HINTS TO TRAVELLERS

ELEVENTH EDITION

VOLUME TWO

ORGANIZATION AND EQUIPMENT
SCIENTIFIC OBSERVATION
HEALTH, SICKNESS, AND INJURY

EDITED BY THE SECRETARY
WITH THE HELP OF MANY TRAVELLERS

ROYAL GEOGRAPHICAL SOCIETY
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PREFACE

IN the preface to the first volume of the Eleventh Edition of this work it was explained that when the new edition was undertaken the Council resolved that the two volumes should be published and sold separately. They are distinct in character and require revision at different intervals. The first volume has long been devoted entirely to Survey and Field Astronomy. The second until now has been in effect a series of chapters on subjects of scientific inquiry and on medical and surgical care, but has had little on organization and equipment, which were treated separately in a booklet 'Hints on Outfit' long out of print.

This present eleventh edition of Volume Two is of much wider range. The first thirteen chapters, forming the first part of the book, embody the experience of many distinguished travellers on organization, camp equipment, food European and native, clothing, packing, personal staff, sledging, dog-driving, camels, caravans, motoring in the desert, flying, camp routine, communications, and allied topics; they contain also the results of inquiry by the editor on technical matters of equipment: the weave of materials for tents and windproof clothing; the design of balanced rations for sledging and high-climbing; the use of pressure cookers; the classification of cameras and theory of exposure meters; and many others.

The next six chapters introduce the principal subjects of scientific inquiry, other than survey, which a serious traveller may and should pursue. The third part of the book deals with the preservation of health, the treatment of injuries, and the diagnosis and cure of disease.

On many matters (other than the last) in this wide range of subjects it is not right to be dogmatic: there is room for much difference of opinion and of adaptation to suit individual tastes and necessities. When, as sometimes must happen, the traveller finds inconsistencies or contradictions in the advice and experience of others, he must do

some thinking and use his judgement. We shall be content if the material here presented is sound, though it cannot be complete.

The arrangement of the book, and the designation of authority wherever possible, will show how much we are indebted to those who have co-operated with the editor. Mr. A. R. Hinks has ably carried out the responsible task of assembling and arranging the data supplied by the various experts, and of editing this volume. In the name of the Society I offer to all the contributors our grateful thanks and the expression of our warm appreciation. In its present enlarged form this handbook should prove of even greater practical utility than its predecessors, and should become an essential item in the outfit of travellers and others for whose use it is designed.

December 1937

HENRY BALFOUR
President R.G.S.

INTRODUCTION

The two volumes into which the late Mr. Coles' small pamphlet of 1854 developed, without change of name, have in the process tended continually to become Handbooks rather than Hints. But in this almost completely new Second Volume of the Eleventh Edition the traditional title has allowed us to adopt naturally a form which necessity imposed: an abbreviated style of writing, a frequent use of the imperative mood in the body of each chapter. Instead of saying that "the traveller will be well advised to attempt . . ." we have said briefly "try . . ." and have used the space thus saved to justify the advice by quoting from recent papers published in the *Geographical Journal*, or occasionally from books.

It was impossible to survey the whole literature of travel, to study and compare the methods of different countries and people. The treatment is founded quite frankly on British experience, and largely upon those travellers who are Fellows of and have contributed to the publications of the R.G.S. This had the practical advantage that a short extract from a paper published in the *Journal* could refer the student back to the original in a single series which many libraries possess.

The work is divided into three parts, dealing respectively with organization and equipment, scientific observation in the field, and the preservation of health or treatment of accidents and disease. The division is rather in style than in format. The first thirteen chapters, on equipment and organization, are compiled from many sources; they cannot cover the ground systematically; they are inevitably scrappy. And some of them must get out of date rapidly as improvements are made in methods, instruments, and technique. The Editor will be grateful for comments and criticisms, to improve a twelfth edition. The next six chapters have the advantage that they can treat at some length of single subjects, or at least of subjects having some scientific affinity, and do not depend upon individual tastes, abilities, or prejudices. The last two have a third character and function: to advise upon measures of health, and upon how to do the best one can when confronted with the sudden emergency of accident or disease. To this extent the book must be considered as having three distinct parts, and different uses.

After some experiment it was found best to approach the subject from the point of view of the leader of a fairly large and well-equipped expedition, rather than from that of a very small and modest party, or of an individual. The latter can more easily select and simplify than the former can elaborate. If it should seem that too much emphasis is laid on polar and on Himalayan travel, the explanation is that British travel has of late years gone that way, and provided much of the best material for the book.

The Editor has had the agreeable task of applying an inquiring mind to cross-examining many distinguished travellers, and extracting from them information and advice to others which they had modestly omitted to give in their published papers. He has to thank them for the way in which during weekend visits they have patiently responded to inquiry and have furnished much of what is most useful in the body of the book. He has also to thank most cordially those specialists engaged in research or in manufacture who have so readily given information on many technical questions. Whenever it has been possible the authority has been indicated in the text; but it has not always been possible, for much is due to combined advice and criticism.

We have tried to deal fully with those matters in which the terminology was confused, as in the classification of tents, and of cameras; or in which numerical specifications were hard to come by, as in the choice of windproof materials for tents and clothing, in the design of compressed rations, and in the management of stoves and pressure cookers. We have taken advantage of much recent British experience in the technique of polar travel by treating more in detail than was elsewhere possible the choice of clothing, the design of sledges, and the management of dog teams. For desert travel by camel or by car we have drawn at some length upon the experience of distinguished exponents of these arts. In the chapter on photography we have been at pains to present opposite points of view; to provide against difficulties in the field while assuming common knowledge of dark-room manipulation, but to deal fully with the remarkable possibilities of colour film, and have been interested in making a table which relates aperture, exposure, and emulsion speed conveniently.

If the treatment of some technical matters seems out of proportion to the rest of the book it must be because the Editor found them

interesting and amusing to himself. The diagram illustrating tents set a rather hard problem, how to distinguish in a small drawing between poles (often in sleeves), edges of canvas, and guy-ropes; to show linings and ground sheets was out of the question. The graph for pressure cookers gave much pleasure in making, for manufacturers could not always be convinced that internal pressure controlled by spring safety-valves was related to external pressure, and that altitude made an important difference. Even the little scale to the right showing the relation between altitude, height of the mercury barometer, and atmospheric pressure in pounds per square inch had a certain novelty. The diagram for compressed rations was suggested by Mr. Augustine Courtauld. It shows more conveniently than any table how rations have been developed, largely on the initiative of Gino Watkins. The composition of foods is a difficult subject on which laboratory analysis and field experience are not always accordant, and on which even the best books are incomplete. We could have done little without the most willing assistance of works chemists. But it is well to insist here, and repeat it later, that the figures of analysis must not be taken too seriously: the second figure is significant, the third more doubtful. But they are essential to planning.

The rather elaborate treatment of photographic exposure meters, lens apertures, and shutter speeds developed gradually and rather late in the day, so that there was no time to discover how far the theory that must underlie the subject, however obscured, had been put in that way before. But it has a simplicity which seemed to justify its inclusion. The amount of moisture in the air is important to photographers who have to guard their films against deterioration, and to collectors who have to dry their spoil. Meteorologists have seemed in the past to be content with finding the relative or percentage humidity without caring very much whether the actual amount of water vapour was great or small. The graph on page 268 is thought to be new. It gives the amount of water vapour, which interests the photographer, and the deficiency from the maximum, which interests him and the collector. It gives the relative humidity for those who want it, and agrees with the tables of the Meteorological Office in this; but it gives the dew-point a little different, and there has been no time to trace the origin of the discrepancy.

The technical inquiry which is least complete is that on the curious

subject of textile weave, important to those who buy tents or windproof clothing. The subject is perplexing to the amateur, and so much depends upon what happens to the woven fabric in dressing and finishing that the figures we have obtained may not prove to be so useful as was hoped; but they may help the purchaser to ask suitable questions.

The chapters of the second part follow in their subjects the plan of former editions, but only three survive, in part; the others have similar titles, but are new. The Medical Hints, now called Health, Disease, and Injury, make a completely new third part.

The constant attribution of Chapters, Sections, or Paragraphs to their respective authors will show how wide has been the experience and knowledge upon which the editor has been able to draw. We are especially indebted to Mr. Augustine Courtauld, Mr. and Mrs. Harold Ingrams, Professor Mason, the Hon. Francis Rodd, Dr. K. S. Sandford, Mr. J. M. Scott, Mr. Michael Spender, and Mr. J. M. Wordie, who advised upon the plan, criticized it as it developed, and contributed at every stage to its completion. Whole new chapters were written by the late Dr. T. F. Chipp; by Dr. Kenneth Sandford; by Mr. W. L. Sclater with Lieut.-Colonel J. Stephenson, Dr. Malcolm Smith, Mr. J. R. Norman, and Miss L. F. Cheesman; by Drs. Carmichael Low and C. B. Warren, with Mr. Alexander MacGregor; and by Dr. J. W. Cope; and there were many others who wrote complete sections as well as contributing much that is incorporated in the general text: Major R. E. Bagnold, Dr. J. R. Baker, Professor G. B. Barbour, Mr. Colin Bertram, Mr. Andrew Croft, Mr. W. E. Hampton, Dr. R. W. G. Hingston, Mr. C. W. Hobley, Mr. Ronald Kaulback, Major C. J. Morris, Mr. Quintin Riley, Mr. John Rymill, Captain L. C. D. Ryder, Lieut.-Colonel F. J. Salmon, Mr. Ivan Sanderson, Lieut.-Colonel Reginald Schomberg, Miss Freya Stark, Sir Eric Teichman, Mr. F. Kingdon Ward, and Mr. J. W. Wright. The list would have been longer had not several important expeditions been in the field when the compilation was in progress. Among those who gave valuable advice and assistance on scientific and technical matters were Mr. A. L. Bacharach, Mr. E. Bilham, Mr. Archibald Black, Professor David Brunt, Mr. Louis Clarke, Major G. P. Crowden, Dr. T. G. Longstaff, Mr. C. F. Meade, Dr. D. A. Spencer, Mr. Humphrey Spender, Dr. Zilva. The makers of tents and fabrics, of stoves and pressure cookers, dealers in cameras and films, and the

chemists of many firms manufacturing foods have already been thanked collectively; it is more difficult to thank individually those who have written on behalf of their firms. Finally we have to thank all those travellers, authors of papers in the *Geographical Journal*, upon whose writings we have drawn so largely to illustrate and enliven our subject.

Notes written for the book at the request of the Editor are printed usually in 9 point type, with the name of the writer affixed; quotations from published papers are mostly in 8 point. The volume and page of the *Geographical Journal* are given thus: 85.264. The reference O.U.E.C.4 is to the fourth annual report of the Oxford University Exploration Club. The names of diseases and afflictions made the General Index look so depressing that they have been removed to a Special Index near the end of Chapter XX.

A.R.H.

CHAPTER I. TRAVEL

THIS book is principally for the use of travellers with their own organization of transport and supply, camp equipment, and followers. Evidently one cannot attempt to cover in detail the needs of different parts of the world. But one may divide the world broadly into polar, mountain, tropical, and desert, for which kinds of travel the equipment is largely different, though mountaineers have recently learned something from polar travel.

Again, travellers may be divided into members of large highly organized expeditions; parties of friends, generally from the Universities, with a considerable proportion of the party inexperienced; and small groups of two or three experienced and hardened people resolved to go far with a minimum of expenditure. Circumstances have encouraged this last type, and young people tend to make a point of travelling to their starting place in the most economical if uncomfortable way; of rigorously controlling their equipment, especially their European supplies, and living to a great extent on native food.

The papers read to the R.G.S. during the last fifteen years, and published in the *Geographical Journal*, have sometimes systematic appendices on equipment and organization, but more often contain useful indications in the course of the narrative. It has seemed well, then, to deal with each subject in a brief general statement of the principles, and to stimulate independence of thought by quoting short paragraphs from recent published papers which appear to give useful, if sometimes contradictory, advice. Each quotation is followed by the name of the author, the country to which the paragraph applies, and the volume and page reference to the *Geographical Journal*, or occasionally to other publications. The intending traveller may be thus directed to papers which will be useful to him in planning his own expedition.

What a traveller can do to advance the science of geography depends upon his knowledge and his special interests. If before he departs on his journey he has made the right preparation for it he will have read the principal accounts of previous travellers and will in the field observe the changes which have taken place since those

accounts were written: the development of administration, of communications, of trade. He will observe the infiltration of alien people, the origin of manufactured goods on sale in the markets, the languages most useful in the intercourse of strangers, the effects of education on the natives, and their adaptability to European methods and machinery and technique.

The good traveller, having provided himself with whatever maps may be obtainable, will note any apparent errors in them and try to correct them by observation. He will also inquire for and obtain copies of any local maps that are not likely to have reached the R.G.S. He will observe the weather and the seasons and seasonal changes, and will try to discover what seasons are the better for different kinds of travel and of scientific work in the field, always remembering that the tendency of weather, especially in local judgement of it, is to be exceptional. He will record changes of names and population, of river courses, of land utilization, evidences of desiccation, of soil erosion due to faulty methods of stock-keeping or cultivation. He will observe what crops are brought to market, the abundance of local supplies, the introduction of new crops, the methods of cultivation. He will study the distribution of trees and flowering plants, the time of flowering and seed ripening. He will observe native methods of building and other crafts, and obtain specimens of native weaving, needlework, and ornament. He will learn what he can of native medicines and methods of treatment. Such are some of the many inquiries open to any intelligent traveller.

With a little special knowledge he may inquire of the British Museum (Natural History) whether there is any beast, reptile, or insect in his area of which they desire specimens; or of the glaciologist what observations of glaciers he should undertake. He may study the characteristics of the few known meteorite craters and keep his eyes open for others. He may look out for antiquities, especially prehistoric rock drawings and paintings, and photograph or copy them, or any inscriptions which may probably be unrecorded; measure and plan any ruins; and collect fragments of pottery which can be dated. He may learn to distinguish the characteristics which are important in the determination of race, and show them on careful photographs; to collect rock specimens which are worth bringing home for identification, or study the nature and arrangement of sands which sing; to preserve plants for the herbarium and seeds for

the specialist gardens. Some of these matters are dealt with in the second part of this book.

But whether he is a specialist or merely intelligent, the traveller may learn to photograph systematically instead of at random, carefully determining by compass resection the position from which rounds of photographs are taken, making every effort to gain good view points, working with a calibrated camera which can be levelled, and recording the compass bearing of one or more conspicuous points in the landscape; taking pictures forward and back and on each flank so that one may study the line of approach as well as the goal of an expedition.

We have said nothing of Survey and determination of astronomical positions to which the whole of the first volume of this work is given. Accurate survey is a whole time occupation, yet the surveyor may in the field find time to observe some of the other things with which Part II of the present volume deals; and the practice of geology or natural history or archaeology demands some knowledge of survey, while for his own safety a traveller in unmapped country should be able to fix his position within a mile or two by sun or stars, preferably by the position-line methods with quadrantal stars, as developed in Vol. I. Since that was published the Air Almanac has been issued, and the tabulation of Greenwich Hour Angle for sun, moon, major planets, and the brighter stars has much simplified the problem; the bubble sextant used in air navigation may well be used also on land for rapid and inconspicuous position fixing. Study also the use of the miniature photo-theodolite if you have any taste for survey.

The accomplished traveller will make every effort to obtain correct forms of geographical names, getting several different natives to pronounce them, and recording in the system known as R.G.S.II, adopted by the Permanent Committee of Geographical Names for British Official Use (P.C.G.N., see Chapter XII). Try also to obtain the names written; though the script of a scholarly Mongol may be unintelligible to a traveller at the time, it may be invaluable to specialists at home.

Remember that the more primitive the people the more likely it is that languages vary from valley to valley, and that the same feature will have different names for inhabitants on opposite sides of it; that even a small island may have several native names; that the name of a river may change every few miles; and that guides when questioned

may more readily invent a name than admit ignorance. In some places there is definite dislike to giving the curious traveller the name of mountain or wadi; on the other hand, in southern Arabia the Badu will repeat a name a thousand times to give a chance of getting it right.

Such are a few of the ways in which a traveller well prepared by reading up his subject may advance the science of Geography. His outfit and equipment will be designed to secure his safety, health, and modest comfort. He will aim at being a self-supporting unit, ready to receive local advice but to form his own judgement on it, happy to accept proffered hospitality but not expecting it or relying on it, for the increase in number of travellers has sometimes put a strain upon the time and the resources of officials.

CHAPTER II. PREPARATION AT HOME

In accordance with principle we work down from the larger organization to the smaller. The smallest party must have organization; even an individual upon a mission or with a grant-in-aid should be guided by somewhat the same feeling of responsibility. And the happy traveller responsible to no one but himself may nevertheless find it useful to study the organization of larger enterprises.

"I find that there is sometimes a good deal of misconception prevalent both among members of the public and also of the Press, as to the extent of the Society's moral and financial responsibility towards those expeditions to which it has given its blessing and support. I wish to make it clear that the Society can neither claim nor shoulder such responsibility. For many years no expedition entirely of the Society's own, as it were, has left the country, and short of that phenomenon, responsibility rests on the individual who submits the plans to the Society for comment. Such plans are studied by the Expedition Committee, and if they appear sound and practicable are commended by that Committee to the Council for the support of the Society. In that case a small grant of money or the loan of instruments probably ensues. But such grants are unfortunately very small, as a rule, for our annual budget allotment for this purpose . . . has to be distributed between some seven or eight expeditions. In a very exceptional case like the Graham Land Expedition, which is regarded as practically a national one, it was felt that an unusually generous contribution was called for. . . . But these indications of interest and support place the Society in no position of responsibility with reference to an expedition so assisted." *President R.G.S.* 86.94.

AGREEMENT WITH ORGANIZER

It has generally been found important to have an agreement signed by all members of an expedition, regulating not so much their allegiance to the leader and their conduct on the expedition, as their dealings with the Press, with publishers, and with lecture agents. Nothing is more annoying to the leader and the fellow members than to find that one member has different ideas from the others on the delicate questions of publicity, or of responsibility for giving an account of the expedition on his return. If there is a committee in charge of the organization the agreement should be with them, and should stipulate that the results of the expedition are in their control, and that there should be no dealings with the Press nor sale of photographs, nor publication without their permission. If there is no committee, its

functions in this respect devolve upon the leader. The signed agreement may never be invoked, but its existence establishes a proper principle, in the above as well as in other matters which may in the event of accident become important, such as that each member of the expedition goes entirely at his own risk, and that no claim for death or disablement shall be made upon the organizer of the expedition by any member of the expedition or his relatives.

If any difficulty arises it is generally in dealing with photographs and moving pictures, which may have important saleable value, and which must not in general be exploited for individual benefit. Such materials should be in principle the property of the expedition as a whole for a definite time. It is often useful for the controlling party to buy out photographic equipment brought privately by individuals, or to supply or repay the cost of material, which then becomes the property of the expedition, but which may in due course be repurchased by the individual. Especial care is necessary when the reports on an expedition have been sold to a single newspaper for the world copyright; see paragraph Publicity and Newspaper Rights (p. 14).

As an example of formal agreement on official expeditions, take this summary of that made by members of the Mount Everest Expedition 1936:

Each member proceeding on that Expedition at the cost of the Committee agreed to carry out all instructions of the Committee and any orders given by the leader or, in his absence, by a deputy duly appointed; that all photographs, collections, observations made during the Expedition should belong to and be deemed to have been made for the Committee; that for three years after the date of first publication of the official account of the Expedition no member would publish any account in any form or hold any communication with the Press, Press agency or publisher, or deliver any public or broadcasting lecture, or allow any information in letter or photograph to be published without previous sanction of the Committee in writing; that if any breach of this undertaking were made the Committee and every member would be indemnified against all damages and expenses incurred by reason of such breach; that each member joined the Expedition at his own risk as to the consequences and that the Committee would not be responsible for any damage, personal or otherwise, suffered during the Expedition; any question arising between the member and the Committee should be referred to arbitration. Agreement signed with 6*d*. stamp, thus making it a contract.

As another example take the agreement made by members of the Oxford University Arctic Expedition 1924, led by Mr. George Binney ('With Seaplane and Sledge in the Arctic,' Appendix H). He would "hate to explode the popular myth that all members of an expedition wore halos *ex officio*. Sometimes the halos are only semi-circular and have a striking resemblance to horns."

An agreement provided that each member should pay an agreed sum into the expedition funds not later than a certain date, to include share of the ship's charter, food during the expedition, and reasonable living expenses; to pay the sum if unable to join the expedition after signing the agreement, unless a suitable substitute is found; to give assistance by photography and collecting; to make no communication or give any interview to the Press; to give the expedition copyright of all photographs, and lend all negatives and prints for a period of eighteen months; not to write any book of popular interest or give lectures for the same period except lectures to learned societies or technical articles and photographs published without remuneration in scientific journals; to bring camera and films and to take photographs suitable for reproduction; to consider collections the property of the expedition, to be disposed of as is thought fit, but if not required, returned to the individual; to accept .... as leader of the expedition and abide by his regulations; to agree that in any serious emergency it is reasonable that his family should be asked to subscribe to a rescue expedition; to work out all scientific results with all reasonable despatch and forward them to the chief scientist in form suitable for publication; in consideration of which the leader agrees to take .... as member of the expedition and carry it through with the best of his ability, having in mind before, during, and after the expedition the interests of the whole and of each member.

An agreement on somewhat the same lines could be made to cover the so-to-speak vested interests of an experienced leader introducing a tyro to a region in which he has already worked.

LEADERSHIP

The discipline of an expedition may be either something approximating to Service discipline, as on Captain Scott's expeditions, with an executive of naval officers, a separate scientific staff, and a personnel of naval ratings; or it may be of the very different kind suitable to a party of University friends. In the latter and much more common

case the discipline will be implicit rather than evident, but thereby all the more necessary. Everything will then depend upon the quality of the leader and his power of rising to emergencies. Some will hold that the leader must impress his position upon the party from the start. Others that the leader will lead effectively only if he is so obviously the best man that others will naturally follow him. Some hold that every one should know as much as possible of the plans, and that they should be discussed with the whole party; others hold that if the leader reveals too much of what is in his mind, some one may rely too much upon this knowledge since he cannot always tell how the plans may be adjusted by the leader to suit circumstances.

"The *Discovery* was legally a merchant vessel flying the blue ensign by special Admiralty warrant, and the burgee of the Royal Harwich Yacht Club in place of a house flag. Officers, scientific staff, and crew signed on under Captain Scott as master; but all voluntarily accepted Royal Naval conditions, and copied the naval routine and nomenclature, the saloon being termed a ward-room, and the men's quarters the lower deck. This touch of the theatre amused the scientific staff and pleased Shackleton, who had always a keen delight in make-believe; but it was taken quite seriously by the naval men, and undoubtedly served to maintain the high standard of discipline which prevailed throughout. Captain Scott, following the usual custom of the Navy in small vessels, refrained from exercising his right of living apart from his officers, and became one of the ward-room mess, taking the position of president at the table in turn with the others week about, and imposing no restriction on the freedom of conversation. He was singularly sympathetic and understanding, always keen to add to his knowledge, and concerned to give to every specialist the fullest possible opportunities for pursuing his studies. On deck he was a firm commander with a stern regard for detail, and strict in the enforcement of duty. . . .

Shackleton had in an exceptional degree the happy power of delegating responsibility and of refraining from interference when he had done so, though ever watchful to resume control should his helpers break down. On the way south he had been occupied mainly in the study of the land party, now brought together for the first time. The conditions were such as to reveal any bodily or temperamental weakness that might exist. He soon found that there was a tendency for groups to be formed, the Australians, for instance, holding together on the one side and the English members on the other, although the genial personality of Professor David did much to draw all together. Shackleton would not have hesitated to send back any man who developed ill-natured qualities; but he found them all good, noting merely the friendships that sprang up, or became obvious, so that he could group them into congenial parties. . . .

As the long winter night went on, the party became a band of brothers, and the Boss, as Shackleton came to be called, gradually acquired an ascend-

ency which owed nothing to authority, but was founded on friendship and respect." *Mill. Life of Shackleton.* 59, 117, 130.

"A delightful companion, unaffected by circumstances and unharassed by responsibilities; liked for himself, because he was so much the better man; unconventional in his methods of leadership, putting himself on the level of his companions, but proving his superiority in unexpected difficulties; always having something in reserve. He got the best out of his companions because they were ashamed to show him anything else. When he had discovered their ability he gave them a free hand, trusted them as they trusted him, and blamed no one if they failed." *J. M. S. on H. G. Watkins.*

Much depends on whether the expedition has a single aim, that of the leader, to which all the members must devote themselves on his account; or on the other hand has a number of separate aims to which the general conduct of the expedition must be adapted. In the latter case there will naturally be discussion of progress at intervals, after which plans for the next stage are approved by the leader. But if in pursuing these plans a party out of touch with the leader discovers something unknown when the plans were made, it must be ready to take the responsibility of modifying the plan if so doing would forward the aims of the expedition.

SECOND IN COMMAND

It is safer to have a leader-designate in case the leader is disabled, and he may carry sealed orders. He will not necessarily be the man who, while the leader is in command, acts as his chief of staff, and is responsible for the detailed running of the party: whose business it is to give the leader leisure to think. Some will consider that the leader and the chief of staff should keep themselves a little apart in a large expedition and should themselves be in the closest confidence in all their plans.

The Oxford University Exploration Club often distinguish between the functions of the leader, who is a senior man, and the organizer who is responsible for much that would ordinarily fall to the leader. This method may be well adapted to the particular circumstances of the University expedition but has evident disadvantages in a division of responsibility.

COORDINATION OF DUTIES

General routine duties must be shared, and disagreeable duties undertaken in rotation. Particular duties should not in general be

assigned too far in advance, apart of course from scientific work. A man with particular aptitudes naturally takes on a job of his own accord, *e.g.* cobbling shoes; but every one should as far as possible have several things to do, duties involving discomfort or disadvantages being shared. Every man must have some definite responsibility, and each should think that he has as much as any other, but certain duties such as those of transport officer must be allotted in advance, for he must have knowledge of native languages and must know his baggage in detail. Specialists should be made responsible for statements of their special requirements which should be approved by the leader at an early stage. Specialists should not overlook the possibility of getting excellent native assistance in their routine work (see Chap. 8: Personal Staff).

"Our plan was to spend the first three months in an intensive scientific survey in the Dulit area, irrespective of all other considerations; to do this really well we needed optimism, good health, and morale. Then, the first job being done, for the last month every one was free to go wherever he pleased, preferably into unknown country, provided everything possible was done to ensure a reasonable margin of safety. This plan worked well."
Harrisson. Sarawak. 82.388.

"Before we had left England I had stated that during the year it would probably be necessary to have one man alone at the station. I have travelled with the trappers of Labrador, who are alone sometimes for eight or nine months, travelling in a much more difficult kind of country than the Greenland Ice Cap. Nothing ever goes wrong with these men through being alone, and indeed there is no reason why it should, since a man travelling alone is always faster and more efficient than he is when travelling with a companion."
Watkins. B.A.A.R.E. 79.362.

"The selection of the best type of party will always be extremely difficult, for every man acclimatizes at a different rate and reacts in a different manner to altitude. One thing is certain: mere records of climbs done with guides are of little value in determining whether a man is capable of doing a full share of work on an expedition of this kind." *Ruttledge. M.E.E.* 1933. 83.9.

REPRESENTATIVE AT HOME

Even a small expedition requires some kind of office and permanent address at home, and a representative with power of attorney to act in case of necessity. The regulations of the Oxford University Exploration Club provide this essential for the explorations under its auspices. The home representative must be familiar with the organization, the names of the expedition, and addresses of relatives;

be satisfied of the financial position, and informed of any accounts left for payment after the expedition sails.

COST OF EXPEDITION

The only general principle is that the cost is enormously increased if the expedition requires a ship of its own. Steamship companies, and less frequently railway companies, are generous in giving concessions on the cost of passages, and commercial firms are frequently willing to present stores, or to supply them at a large discount. But it is a delicate question how far it is allowed for an expedition to become an advertising agent by accepting gifts on the condition that they should be mentioned, and some authorities make a rule against this practice.

The modern tendency of younger travellers to voyage uncomfortably, to dispense with luxuries, to live on native food but not cooked in the native way, has very much in its favour. But individual reactions to hardship vary so much, and so much depends also upon the work which the expedition has to do, that no rule can be made other than that adequate assistance and reasonable comfort may be necessary for the scientific work, and that the governing principle should be the maintenance of health. Many will hold that a traveller should live as well as he can for as long as he can. But absence of luxuries is not always actual discomfort.

"Aim to pay for service, transport, etc., a little, but very little, more than a native would spend: a little more will obtain more ready service, but too much attracts all sorts of undesirable people. Many difficulties come to British travellers from scattering more money than is required. In Persia I paid 4*s*. a day for two mules and either one or two men: another 1*s*. at most for odd payments in villages. In tribal country I never paid for hospitality. In Southern Arabia, during the only week in which I paid for my transport, the cost was 11*s*. 6*d*. a day for four donkeys and three men and their food. I reckon that when actually trekking my average cost should be less than 10*s*. per day: and the cost of the whole journey from the base (*e.g.* from Aden into Arabia, or Baghdad into Persia) I usually plan on the basis of £1 a day including my stores. One can get about the East very cheaply now by taking seats in native cars: from Resht on the Caspian to Baghdad £2 10*s*.; from Baghdad to Jerusalem (by lorry and quite comfortable) £3." *Freya Stark.*

"It was necessary to conduct the expedition with the strictest regard to economy. Careful accounts were kept of expenses both in England and India. The total cost worked out at £287. We were in the mountains for just under five months. On Dr. Longstaff's advice the party was a small one, and I was extremely lucky in having four ideal companions. They were H. W. Tilman,

with whom I had climbed a good deal in East and Central Africa; Angtharkay, who was one of the two Sherpas on Mount Everest last year who sat through that three-day blizzard at Camp 5 and then volunteered to carry to Camp 6; Passang Bhotia was another Camp 6 man; and lastly Kusang Nangir, a man of extraordinary toughness and imperturbability."

Shipton. Nanda Devi. 85.308.

"The total cost of the expedition (excluding the seismic apparatus) was £472. [Six men: two months away from England.] Messrs. Pickering and Haldane's Steam Trawling Co., Ltd., afforded us our outward passages to Iceland; Commander F. W. Hawkridge made this possible; and many firms and individuals assisted us generously. Cadbury Bros. and Bovril Ltd., presented provisions. The organization of the expedition was greatly facilitated by the use of a room at the Scott Polar Research Institute."

Roberts. Iceland. 81.291.

"The total cost of the expedition was £980, being £8 over the estimate for the full year. [Three British and native staff.]"

Sanderson. Cameroons. 85.134.

". . . five weeks on the island would be as long a visit as we could reasonably expect. This working period would almost certainly be curtailed to an unknown degree by fog in August and in September by gales and foul weather. There would be no time to tarry on the Labrador coast going north. To get to Akpatok as quickly as possible and remain there as long as possible was our one idea. The cost of the expedition was estimated not to exceed £1500, over £1000 of which was subscribed by members [10 from Great Britain]."

Clutterbuck. Akpatok I. 80.212.

Libyan Desert 27 *September*–29 *November* 1932: 6000 *miles of which* 5000 *over new country*: 8 *members*, 4 *cars*.

Four Model A Ford car chassis	£E.532.000	
Four specially designed bodies	110.500	
Tyres and tubes	97.220	
Tools, spares, and garage work	89.064	
Special radiators (unsuitable, not used)	14.521	
Registration and insurance of cars	41.340	
Miscellaneous	12.435	
Less Spares and tyres returned after expedition	41.917	
Sale of cars	237.500	net 617.663
Petrol for running cars	2.080	
Petrol at Cairo, Kharga, Selima, and Fasher—total 1712 gallons	191.660	
Oil, ditto, total 36 gallons	9.715	
Transport Halfa to Selima, etc.	25.360	
Containers, etc.	6.000	
Less Supplies returned	4.105	net 230.710
Purchase of food	82.538	
Less Sale of surplus	3.750	net 78.788

W/T signal set, batteries, valves, etc.	13.725	
Insurance of instruments	6.811	
Maps, duplicating, etc.	8.353	
Overhaul of chronometers	2.037	30.926
Transport of stores to Egypt, etc.	6.505	
Postage, telegrams and cables, clerical work, duplicating, etc.	11.044	
Miscellaneous purchases	9.774	27.323
	Net Total	985.410

Bagnold. Libyan Desert. 82.234

The Oxford University Arctic Expedition 1924 had two ships, the *Polar Bjørn*, a sailing vessel of 164 tons chartered at £98 per week for a minimum of 10 weeks; a sealing sloop of 27 tons, chartered at about £4 a day; and a seaplane built by Messrs. A. V. Roe, for which Messrs. Armstrong Siddeley lent an 180-horse-power Lynx engine. The expedition was away about 90 days. It cost £5300 and would have cost £8300 if it had not been for gifts and loans. Appendix D of 'With Seaplane and Sledge in the Arctic' shows that the proportional costs on the total of £8300, that is including the value of loans and gifts, was about:

Charters of two ships	18 per cent. total
Fuel and lubricating oil	6·3
Seaplane and spare parts	30
Ship's food and gear	10
Sledging gear, food and dog-drivers' charges	6·2
Film	6·9
Travelling and freight	4·4
Wireless and scientific instruments	7·5
Administration	3·1

with smaller amounts for alterations, insurance, gratuities, etc.

The inclusion of the seaplane made the percentage cost of ship charters relatively small.

"So ended a journey which covered about 3500 miles and lasted for seven months all but three days. It cost us about £150 each."

Fleming and Maillart. Peiping to Srinagar. 88.143.

METHOD OF SHARING EXPENSES

When the costs of an expedition are shared by its members, perhaps with assistance of grants from scientific societies, it is a good principle that every one should contribute a reasonable minimum, at least as much as it would cost him to live at home. It is generally unsatisfactory if individual members receive pay from the expedition funds, or go under an arrangement designed for their private profit, as by the sale of photographs. This applies in full only to sharing expeditions, or partnerships; but the principle is applicable to

expeditions of a more official or public kind, that no one should be in a position to make individual profit from a joint enterprise.

"Each of the members contributed as much as he could reasonably afford, and from this source as well as from grants, and receipts from press and lectures, £4000 will finally be forthcoming. This will be enough to cover the total expenses of the expedition, as well as the costs of publication of scientific results. [10 men: 14 months.]" *Glen. North East Land.* 90.193.

ESTIMATES AND LIABILITIES

Having made the most careful estimates the organizer should submit them to independent check. Even if experienced he will find it necessary to allow from 10 to 25 per cent. for the unexpected; if inexperienced at least 50 per cent. The organizer is generally in the difficulty that adequate means should be guaranteed before stores are ordered and a ship chartered, while on the other hand until his preparations are some long way advanced he cannot complete his party or obtain the necessary permits for his journey. He must therefore be prepared to take risks and if contemplating a party of eight may charter a ship when five or six are certain. The last members of a party are often obtained a week before sailing. Much will depend upon whether the expedition has a supporting committee at home prepared to guarantee a temporary overdraft.

The leader must be careful to avoid giving the impression that approval of his plans by official bodies implies financial backing.

The funds of the expedition must be kept in a separate banking account, and the leader must leave all his accounts in good order when he starts, so that his representative at home may have no difficulty.

PUBLICITY AND NEWSPAPER RIGHTS

An agreement with one newspaper for world rights has proved to be the only way of getting substantial money in advance; there may be agreements by the purchaser for resale, but there should not be separate contracts with newspapers in different parts of the world. If a newspaper contract is made it is particularly necessary to insist on the strict observation of the clause in the agreement signed by members of the expedition that they shall have no communication with members of the Press. Every despatch should be signed by the leader, who will be responsible for the tone of the despatches.

It would be very advantageous if the newspaper which takes the service of news could be persuaded to publish the messages exactly as received, with the place, date, and time at which the despatch originates, especially if it is sent by telegraph. A newspaper is apt to suppress the date and time, and to date the message merely the day before the day of publication, in order to give the impression that the news is quite up to date, even though there may have been delay in transmission. This may be very embarrassing to those at home who are following the progress of the expedition with expert knowledge.

INSURANCE

It is difficult to insure personal risks, and attention must be given to special endorsements; or notification on life policies or to the managers of contributary pension schemes. Many companies require an extra premium for residence or travel in the tropics.

Ship charters may include insurance; see that the policy has actually been taken out. Special ship insurances for voyages in ice or outside the summer season are required. In Norway ice insurance is ultimately placed in London.

If the finance of the expedition is contingent upon contracts for news, consider insuring against failure of the expedition to gain its objectives.

The R.G.S. has a floating policy of insurance to cover all the instruments on loan, and the borrower is required to pay an appropriate fee, which is much less than he would have to pay for individual insurance of the same instruments.

EARLY PREPARATION

Ample time must be allowed for obtaining the necessary authority to enter the territory in which it is proposed to work. A first application should set out the proposed scheme of travel, the composition and nationality of the party, and the duration of the expedition. This application should promise a more detailed statement to follow as soon as possible. The passage of diplomatic channels is necessarily slow. Make early inquiry also on arrangements for obtaining money.

Meanwhile the stores must be completely collected well before starting, and first attention should be given to anything which must

be made specially for the expedition. So far as possible all stores should be collected in one place, and the best advice taken on problems of packing and loading: size of cases, contents, and labelling. Most careful attention must be paid to avoiding large charges which arise from delay of a ship in dock, or of storage pending clearance on arrival, especially delays due to inadequate preparation for Customs facilities (see p. 19).

"Anyone contemplating a journey in Central Asia should begin preparations not less than a year in advance. A successful trip cannot be improvised." *Schomberg.*

"I believe it was due to our having at the outset a complete list of all equipment, down to the last drawing-pin, and also to a process of monthly stock-taking, that we never needed to replenish our supplies nor had anything superfluous by the end of the trip. All along, the principle at the root of the organization was the elimination of anything that was not absolutely essential to the work, even at the expense of personal comfort, so that as much time and money as possible might be devoted to a continuous routine of scientific work, and the utmost mobility secured in country far removed even from native villages." *Sanderson. Cameroons.* 85.114.

PASSPORTS AND VISAS

It is essential to inquire well in advance on the regulations imposed, and the particular difficulties in each country, and to take advice on the troubles arising from unsettled political conditions in many parts of the world. A passport and visa granted by a central government may not be recognized by effectively, if temporarily, independent local authorities, and still less may permission obtained locally be recognized by the central government. Some countries are willing to grant permission only on what may be prohibitive conditions, such as that the expedition must be accompanied by a local officer whose pay and field allowances are the charge of the expedition, or that a certain number of members of the party must be natives of the country in which the expedition is to work. In Buffer States there is often discrimination against the people of bordering countries to the advantage of those who are not neighbours. The principles of self-determination and of economic nationalism have increased the political obstacles to travel.

Inquire particularly what permits to carry arms are required, and from whom they are to be obtained, *e.g.* from central or local authorities.

SPECIAL PERMISSION FOR CERTAIN COUNTRIES

Ordinary visas do not apply to certain special territories, *e.g.* a passport available in Denmark requires a special permit to visit Greenland, and similarly permission is required to enter much of Arctic Canada; such permission can generally be obtained without undue difficulty by properly accredited travellers, but there are other countries which it is much more difficult to enter. No one may pass the northern frontier of India without permission of the Indian Government. That permission is not given unless the traveller has obtained through the India Office permission to enter certain neighbouring countries, *e.g.* Tibet except for the trade route as far as Gyantse. Attempts, sometimes in the past successful, to obtain entry by leave of local governors without reference to the Government at Lhasa, are severely discouraged, as apt to cause eventual difficulty both to the temporarily successful traveller and to others who may be applying for permission through the proper channels. Early application to the Under Secretary of State for India is desirable, for all proposed expeditions on the Himalayan border, since communications with neighbouring authorities are apt to be slow and the quantity of transport available makes it impossible to allow more than one or two expeditions at a time in any district, even within the borders of British India.

Leave to enter Tibet is difficult to obtain, and it is out of the question to ask permission to visit Bhutan or Nepal, whose treaty relations with the Government of India provide against any application for permission to enter. In the Yemen travellers must keep to the main road between capital and coast, and go under escort.

Canada requires that the expedition shall prove itself well equipped and that there is no reasonable probability of its getting into difficulties which require relief. Some countries, *e.g.* France for the Sahara, require a substantial deposit against the cost of possible relief expeditions.

A leaflet of the Danish Ministry of Navigation and Fisheries, dated 7 August 1930, provides that no one may travel in Greenland without special permission of the Danish Government. Application must be made to the Minister in charge of the Administration of Greenland through the Government of the applicant's country, and must contain full particulars of qualifications and a recommendation by his Govern-

ment. The applicant must furnish the names and nationalities of all members of his expedition; the proposed route, and especially whether it wishes to be conveyed by the ships of the Greenland Administration; the date of arrival and contemplated duration of stay; the object of the expedition; what it proposes to do; what equipment is carried, and whether this equipment is to be conveyed also by the ship of the Administration. The expedition must provide such security as may be required for payment to the Greenland Administration for conveyance, freight, advances, and supplies. Each member must produce a medical certificate on the day before his departure. Every traveller in Greenland must engage himself to observe the laws in force and regulations and directions named by the authorities. No one is permitted to make excavations in the Eskimo and Norse settlements or graves without special permission, and any one desiring to give geographical names to localities visited must submit them to the Danish Government with whom the final decision rests. Two copies of all publications must be sent to the Danish Government.

"At no time is it easy to obtain the necessary permits from the Persian Government, who are anxious for the safety of foreigners and fear lest Luristan might give the visitor a too sensational impression of their country. But the time which I had chosen for making preliminary arrangements at Tehran was especially unfortunate. A very bad impression had been created in official circles in Tehran by the narrative which a foreign expedition published in a newspaper, particular exception being taken to the account of thrills and perils. The ultimate effect was an order from a high authority forbidding travellers to enter the Luristan and Bakhtiari provinces, and I was the first to feel the weight of this heavy penalty." *C. Sykes. Iran.* 84.327.

"It is scarcely necessary to say that interior Arabia for the European and Christian is still a forbidden land. The traditional British official attitude, the attitude of the Treaty chiefs, and of the inhabitants themselves is a common one of opposition to any outside intrusion. This attitude, in the light of insecurity and religious fanaticism within, is immediately intelligible. No authority will, or can be expected to, allow itself to be actively involved in the responsibility for life or property in such a land. To ask for official approval to a scheme of exploration is thus to invite refusal if not prohibition. . . . No one in Muscat knew of my plans or movements except the Heir Apparent in the absence of the Sultan, his father, for my plans required the utmost secrecy. Exposure would, in all likelihood, have raised the countryside ahead of me. The news would have spread, as all news does spread in Arabia, at an alarming pace and with undesirable accretions. The suspect spy would be barred entry or exit. To ask a Badu's permission to visit his habitat, the waterholes and pastures of which are his chief possessions, is generally to invite refusal. To arrive unheralded connotes in his fatalistic mind, one dares hope, an event in accordance with the Divine Plan."

Thomas. Rub' al Khali. 78.210, 11.

CUSTOMS FACILITIES

The increase of expeditions has made some governments unwilling to grant free entry of stores if they are obtainable in the country. Hence arrangements for Customs concessions must always be carefully arranged well in advance. Make sure that there is no discrimination against fire-arms, drugs, scientific instruments, etc. The leader or responsible officer must see all stores through the Customs both out and in, and control all such things as instruments of foreign make which have been purchased in England duty paid, or stores which have been shipped from bond duty free, in order that there may be no difficulty on the return of the expedition. Take particular care to arrange in advance with the Customs authorities that scientific collections, undeveloped films, instruments and other delicate things should not be subject to search at the port of entry, but should be sent through under seal to some place at home where they can be unpacked by the specialists of the expedition in the presence of a Customs officer. The authorities have shown themselves very willing to grant these facilities if they are warned in advance.

Since the imposition in Great Britain of a general 10 per cent. *ad valorem* duty upon all imports not subject to special tariffs, claims have been made for payment of duty on such things as the value of the undeveloped images on photographic plates, especially if they have been insured on the return voyage for an amount reckoned rather at the cost of obtaining them than for their prospective market value, generally very small.

The laws of many countries, *e.g.* Egypt, Iran, Iraq, Palestine, and China, require special permits for shipping specimens of antiquarian or archaeological interest, which must be passed by their own expert advisers.

NATIVE PREJUDICES

The traveller will study the prejudices of the people in whose country he is to work, to avoid accidental and unintentioned offence, and to do this he must have some knowledge of their historical background, and of their religious observances. Most important are those connected with food: its origin, as from some forbidden animal; its preparation, as by a person of different faith; or its con-

sumption during prohibited hours. The shadow of an alien falling upon the food may be enough to spoil it. The consumption of beef essences may offend, and false labelling is doubtful. In many Buddhist countries there is a whole set of rules which must be obeyed in passing Mani walls and Chortens. There is prejudice against the geologist who breaks rock and releases the demons enclosed. There are superstitions related to particular localities such as the lakes in Chitral which it is dangerous to visit. There are many objections, and for various reasons, to being photographed. The subject is too vast for general treatment: but make careful inquiry of diplomatic and consular representatives on the spot before taking the field (see Chapter VIII).

"The machinations of the collective female mind and convenient by-laws promulgated by ephemeral ju-jus are the cause of many insurmountable difficulties and endless palaver in West Africa. The refusal to assist in collecting is prompted by laziness on the part of the men, who foist all work, especially when it may prove laborious, upon the women. If they in turn decline, or a convenient ju-ju taboo can be unearthed, the whole village loses interest in Natural History with singular promptitude."

Sanderson. Cameroons. 85.118.

"Matters were complicated by the fact that one of the bushmen was a moli, or chief, who had to prepare his food on a separate fire. This taboo meant that we could not share our remaining tins of compressed meat. On one occasion in error I offered him some food which had been cooked on another fire. On learning of the mistake I hastened to inform him, whereupon he was immediately sick and complained of stomach pains for the rest of the journey." *Bird. New Hebrides.* 85.224.

"Like most pagans, all the local tribes were very superstitious. Good and bad omens can interfere with the best-laid plans, especially when an unpleasant or difficult job is on hand. Our first week in the base camp was completely disorganized by an unfortunate omen snake which was finally placated with much ceremony, hens, eggs, and *borak* rice-spirit. Spider-hunters (*Aracnothera*), which are perhaps the commonest birds in the rain-forest, are the main omens. Normally no particular notice is taken of them, but on an expedition into new country or up an unclimbed mountain, where the natives are unwilling to go, bad omens are always available and can be a great nuisance." *Harrisson. Sarawak.* 82.391.

PRESENTS

One must be prepared to give presents, and consider carefully whether they shall be taken from home or bought locally. One cannot be too generous, but at the same time must take great care not to spoil the market, and that presents never give any impression

of bribery. Do not insult a host by offering a present of money, but pay when one can for services rendered, and give alms when they can be given properly, as to religious and charitable bodies. Some people, such as the Eskimo, value presents as tokens of esteem rather than for their intrinsic value. Similarly Arabs like something with personal connection with the giver, who should look ahead and himself use openly first what he will afterwards give away. Orientals generally value fire-arms, which should be left with very little ammunition; but avoid giving revolvers. Medicines are very useful as gifts. Homburg hats are always acceptable in Buddhist Himalayan countries. To a Chinese "gaining face" in presence of subordinates is more important than the actual gift. Overdoing presents gives the impression you have more important aims than you profess. For local headmen and others who may assist, include electric torches, pocket knives, and small tool outfits. Eskimos are made happy with biscuits and cigarettes. Knives, coloured yarn, beads, necklaces, salt are widely useful. Snuff and scent are desired by the Tuareg, and doubtless by others. Very often the discarded tins, bottles, and jars of a camp make the best presents, highly valued by primitive native folk. On presents for more important people and the rules for exchange of presents previous travellers should be consulted.

In Arab countries it is good to send back to an official who has been helpful some present inscribed with the name of the traveller. Women travellers can give presents to the women; men must leave them for "the people of the house." Lengths of embroidered silk, fancy bags, scents, face powder, coloured silk handkerchiefs, and cheap jewellery are all popular. After climbing expeditions in the Himalaya it is well to present porters who have done good service with some kind of medal or token.

For south-eastern Tibet a large stock of presents must be taken to give to the high officials, and it is a mistake to assume that gaudy trash will serve the purpose. Many of these officials have been as far as Calcutta, and many more send couriers to India every winter to buy luxuries for their households, so that whatever is given must be of the best quality. Field-glasses, gramophones, and European shoes (size 7 is usual) are always much appreciated, while for less important gifts raincoats, Trilby hats, and umbrellas are very useful.

R. Kaulback.

"In tribal country where hospitality is not paid for, the best presents to

leave in return for food and lodging are such things as tea, coffee, or sugar, whose value is known, rather than unknown European things whose value is doubtful. Women everywhere like scissors, mirrors, safety pins, thimbles, needles, combs, etc. . . .: and toys with a joke to them are everywhere so popular that they are hardly ever allowed to remain in the hands of the children. To governors, etc., from whom one receives more particular help, it is better to send presents later on: this is a very good precedent to establish, since it encourages courtesy to travellers who may have little to give actually with them: in the Hadhramaut I found such a tradition already existing, and on my return to Europe, after six weeks' hospitality there, I spent about £25 in presents, including large framed photographs of my hosts, which are always popular, and things like writing cases, mirrors, electric torches, etc."
Freya Stark.

"In Central Asia cutlery is always appreciated, and table ware for Chinese is always welcome, as none can be procured locally." *Schomberg.*

"About twenty big savages stalked out and stared at me, so I shook hands with tremendous friendliness, and they just went on staring. Then I gave them all sticks of tobacco and they pretended I had not given them anything, which is the correct behaviour on receiving a present in Sara."
Mrs. Baker. New Hebrides. 85.230.

"He now gave me four bulls as a present, indeed, throughout my stay in Aussa, as in Badhu, I received a most lavish hospitality: daily oxen, sheep, milk, and durrah bread were brought into my camp as presents from the Sultan. What to give as presents in return it is not easy to know, for in Danakil the dollar is all but valueless, and I was interested to find that the Sultan is far from anxious that its use should become more widespread, believing that this would weaken his hold over his tribesmen. I found that *abergerdeed*, or calico, was always acceptable to them, and to a lesser degree small blue, red, or white beads, berberri, and round trade balls of tobacco. Both sexes and even the small children chew tobacco, but I never saw them smoke."
Thesiger. Danakil. 85.14.

CHAPTER III. ACCOMMODATION

GUEST HOUSES AND DAK BUNGALOWS

THE traveller will inquire whether he will find guest houses of some category available, or whether he will have to camp. Many administrations maintain houses for the use of their officials which a traveller may receive permission to use. For example in Egypt every organization, official and unofficial, has its rest houses and in the aggregate there must be thousands of them: of the public services probably the Irrigation Department have the most complete system in the Nile valley; in the more remote places there are good Frontier District Administration rest houses. Banks, cotton, sugar, and other companies have their own houses. It is essential to obtain in advance from the recognized authority permission to use these houses, which is usually freely given without charge. Such permission must not be abused and the traveller must remember that he has no control over the guard or other occupants. In general the rest houses are furnished and have some kitchen utensils: bedding and personal gear are necessary, and a personal servant. Country produce can be obtained through the guard. Always find out in advance the present condition of rest houses, as they deteriorate rapidly and may become ruinous. It may happen that the wives and families of junior local staffs become established in the less frequented houses, which thereby become inconvenient and are best avoided.

Rest houses in the Sudan are much as above: in the north brick buildings usually with some furniture; the Government charges a rent for use. In the south *tukls* (thatched huts or houses) usually in a thorn compound but some more permanent buildings. Permission and inquiries as to position and condition are necessary. If necessary a new compound and hut of the *tukl* type, or shelter, can be cheaply and quickly made in the south. Old buildings often harbour snakes, scorpions, etc.

In the Himalaya the Dak bungalow has a permanent cook who can sometimes obtain supplies. The rest house has only a Chowkidar in charge who takes the money for its use. It is generally possible to obtain permission to use the bungalows belonging to the Forests, Public Works, and Military Engineer Services. Much trouble has

been caused by travellers camping in the compound and expecting not to have to pay the usual rates for use of the bungalow.

In the Aden Protectorate there are two Residency rest houses: one at Dhala and the other at Abyan. Both can be reached by car and are available for hire by Europeans granted passes to visit those places. Most of the chiefs in the Aden Protectorate provide accommodation for guests whom they invite. In Mukalla the Sultan has a guest house in which he usually accommodates his European guests. It is furnished, equipped with a European bath, and electric light (which, however, is put out at 10 p.m.). It is in charge of a steward, who looks after the comfort of the Sultan's guests. In the interior of the Hadhramaut there are houses in such places as Shibam in which European visitors are accommodated.

In the Hadhramaut there are also rough stone shelters, called *muraba'as*, set at intervals approximately of only a few hours' journey on the more frequented routes. They afford shelter from the sun and protection from cold. They are low buildings, have no windows, and only a gap for the door. Water is usually procurable in artificial pools near the muraba'as. Unfortunately the Badawin are in the habit of taking inside such animals as can pass through the low openings, so that the places soon become rather like stables.

"We camped that night outside one of the Government rest-houses which are scattered all along the length of the *Route Royale*. I mention this camp because it was the first we sampled. But not only in the Congo, but all along our 3500-mile route from Rejaf to Gao on the Niger, there were these periodic rest-houses. They were not luxurious; we never slept inside one; but they were shelters on the road where Muhammad never, even in apparently unpopulated wastes, failed to be able to recruit labour—men to fetch water and to hew wood; and women to sell and pluck as many skinny hens as we could eat." *Tweedy. Central Africa.* 75.3.

"The caravan roads of the Hadhramaut are also remarkably well organized, for apart from the many natural springs and water-holes the more important routes are well provided with *siqayas*, or public fountains, near villages, and *qarifs* or *naqbas*, artificial pools and cisterns for rain water, in the desert places. There are also *muraba'as*, rest-houses, at intervals approximately of a few hours' journey over the principal routes crossing barren country. *Siqayas* are usually endowed, and it is the duty of some one in the village near which they stand to keep them filled with water for the benefit of thirsty travellers. *Muraba'as* are built mostly by wealthy merchants to afford the traveller shelter from the sun during his midday halt and rest and security at night. There are also in many places graves of saints at which travellers may leave

their property under the protection of the saint until they wish to reclaim it. The system works very much like railway left-luggage offices, but there are no fees to pay." *Ingrams.* 88.530.

TENTS

Choice of small, light tents for climbing, sledging, or rapid travel depends on whether they have to stand cold or heat, wind, rain or snow; whether lightness or ease in pitching is more desirable; whether they will be pitched on snow and ice, rock and stones, sand or mud; whether they shall be mere burrows for shelter, or give room to live and work in; whether they are required in numbers and inexpensive, or few and durable. The tent may be double, against sun, when the air space between the two is well ventilated; or against cold, when the air space is as tightly enclosed as possible; or against rain, when the principal point is that the wet tent should not be touched, or the rain will come through at once.

Pitch all tents drawn from store before starting, to find holes, and test ropes. Go into camp for a day or two before starting away, to make small improvements. Remember to take spare materials for mending, and extra rope.

All tent poles should be jointed: long poles are a perpetual nuisance on pack animals, and in forest or narrow passes. Pack all ropes inside the tent and check every day. Carry spare ropes well concealed; rope is irresistible to camel men.

INSULATION

Laboratory tests show that the colour of fabric linings has little importance, but that the recent invention of fabrics coated with bright aluminium foil has many important applications. It reflects well and radiates badly, and may be used for protection against either heat or cold. If the usual air-space between the outer wall and the inner lining of a light building such as bungalow or hut is divided into two by a screen of foil bonded to asbestos paper or felt with bitumen, little heat can pass either in or out, and the inner surface of the ceiling or wall is kept within a degree or two of the air temperature within. Similarly, storage boxes for food or drink or photographic materials can be thus insulated with great effect. For best results use the foil-fabric stretched in the air-space between the outer and inner walls or looped between the roof and the ceiling.

Alternatively, use the fabric for the inner wall or the ceiling. To protect against outer radiation have the air-spaces well ventilated; to keep warm inside, have them closed.

For tents, awnings, car hoods, etc., the foil is applied to one or both sides of a cotton fabric, hung with an air-space below the outer covering. Tests with a radiation thermopile have shown that such an inner lining may radiate as of temperature only 2 or 3 degrees higher than that of the air, while the inner surface of the outer tent shows 50 degrees higher. See papers by Major Crowden, R.A.M.C. (T.A.), in *The Lancet*, 6 January 1934, and in *Engineering*, 12 October 1934.

The fabric Foiltex for tent-linings is made by Adam and Lane and Neeve, Ltd., Falcon Works, Copperfield Road, London, E.3 Aluminium foil reinforced by felt or paper, for insulating roofs and walls of buildings, is made by Turner's Asbestos Cement Co., Asbestos House, Southwark Street, London, S.E.1.

The first base hut of the B.G.L.E. was two-floored $22 \times 15\frac{1}{2}$ feet, insulated by Turnall asbestos reinforced aluminium foil hung in the 4-inch space between inner and outer roof and walls. The ceiling of the lower room was also covered. An Aga Cooker Model 62 below and small anthracite stove above warmed the insulated hut. The thermometer in the lower room at 09^h local time, 12 feet from the cooker and shielded from direct radiation, was always about 25° higher than the external temperature when it was between 35° and 20° F. during summer and fell only for a few days below 40° when external temperature was −6° F. A report and temperature chart by Mr. J. I. Moore are deposited at the R.G.S. by Mr. Rymill, with samples of the foil.

CLASSIFICATION OF TENTS

The nomenclature is confused: we will try to classify tents by the number and arrangement of their supporting poles (jointed into lengths of 3 feet or less). The roof is the sloping part which receives vertical rain; the walls (if any) hang from the roof; the eaves are properly the part of the roof which projects beyond the walls but sometimes a flap on the roof to carry off rain; the fly is a separate outer roof for protection against sun and heavy rain; the ground-sheet makes the floor of the tent: it may be sewn in, or taped in, or separate; the guys are the ropes which stay and stretch the tent, made fast to pegs driven into the ground, or to boulders, sledges, etc.; the skirting

is a broad flap of canvas round the bottom of the tent which lies on the ground outside and is weighted with boxes, stones, or snow, or with an inner tent is turned inwards under the edges of the ground-sheet (loose).

What is badly called a double-fly tent is a tent with a fly. The term "A" tent has been used for several different constructions, and means no more than a ridge tent without walls.

Weights are given complete with guys and pegs, and packed in bag, unless otherwise specified. Dimensions are given in feet: length, width (ground plan), height. Since prices depend upon quality and can be studied in the makers' catalogues, we give prices only for a few special tents made to order. The names given by makers are in Italic. Those suggested for permanent use are in Italic capitals.

A. One-Pole Tents

1. *BELL* tent, round, with central pole supporting sloping roof stretched by guys, and more or less vertical walls depending from the roof, generally under an eave. Pin at top of pole to pass through eyelet sewn in to apex of roof, but generally no pin below, the pole being held firmly in place by tension of guys. Walls low: say 2 feet; if 3 feet or more may require short additional posts for support.
2. Similar but rectangular, larger up to 18×14 feet with 6-foot walls for base camp comfort.
3. *LOGAN* tent, rectangular but pole not central, to give head-room at entrance.
4. Central pole with umbrella frame supporting circular tent pegged out to ground: no guys. Used by Survey of India on Pamirs in 1913, but not now often seen: worth consideration.

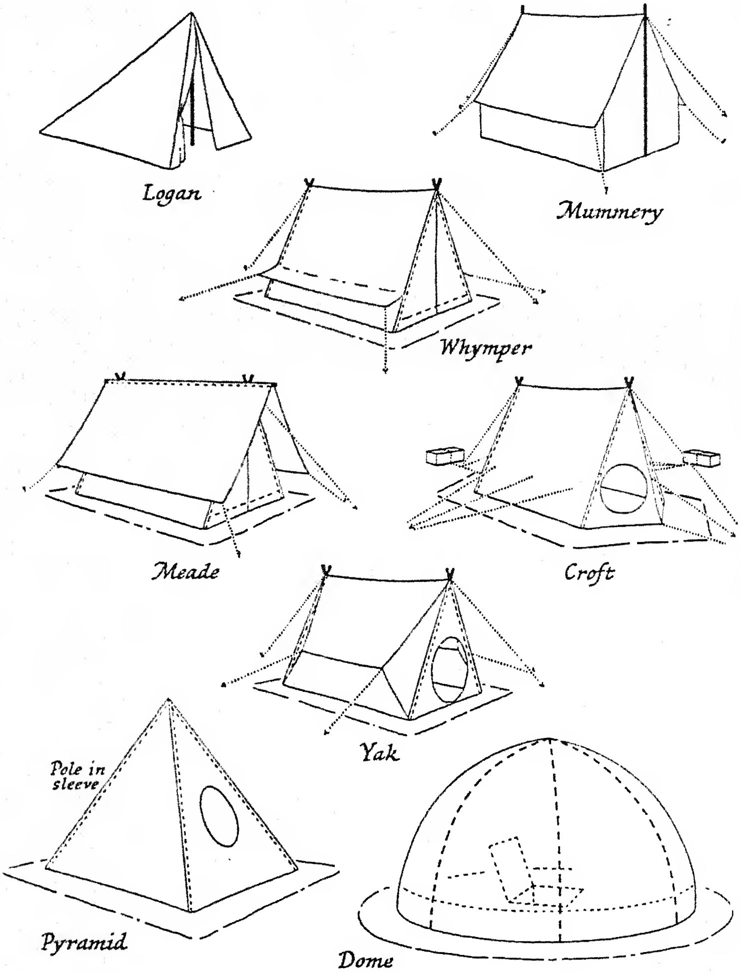
B. Two-Pole Tents

1. *MUMMERY* tent: two vertical poles through loops or rings; no ridge pole; principal guy sewn into canvas ridge and made fast to pegs back and front in line of poles; side guys to stretch roof; walls vertical or sloping inwards in smaller sizes; eaves except in smallest sizes, but often too narrow; in many patterns; may be made very light, but with its many guys takes time to erect.

Fauna (Burns), in many sizes and materials.

Cabin (Camp and Sports), $6\frac{1}{2} \times 4\frac{1}{2} \times 5$; walls 1; Willesden linenette, $6\frac{1}{2}$ lb.

Mummery (Edgington), $6\frac{1}{2} \times 4 \times 4$; walls 2; Willesden drill, 10 lb. Aero fabric, 6 lb.


Logan
Mummery
Whymper
Meade
Croft
Yak
Pole in sleeve
Pyramid
Dome

Patrol (Edgington), $6\frac{1}{2} \times 6 \times 6$; walls 2; Willesden canvas, 40 lb.
Wedge (Edgington), $6\frac{1}{2} \times 5\frac{3}{4} \times 5\frac{1}{2}$; no walls; pegged down; Willesden drill, 12 lb.
Coolie Pal (Survey of India), larger.

2. The above, fitted with ridge pole pierced to fit over pins of vertical poles, to extend beyond them, and carry a fly. The tent has still the rope ridge which sags a little and keeps tent away from fly.
Double-roof ridge tent (Edgington), $7\frac{1}{2} \times 7\frac{1}{2} \times 7$; walls 3; Willesden canvas, 90 lb.; and larger sizes, more elaborate, with verandah, bathroom, etc.
The Field Officers' Kabul Pal and the Round-ended Miniature Swiss Cottage tent (Survey of India). Similar to the simpler and more elaborate respectively.

3. As above, but with ridge pole fitted with screw eyes at ends to slip over pins on vertical, and not extend beyond.
Ridge tent (Edgington), $8 \times 7 \times 6\frac{1}{2}$; wall $2\frac{1}{2}$; and larger sizes.
Cottage tent (Camp and Sports). Always with fly. Many sizes, weights, and qualities.
Field Officers' Kabul Pal (India), 9×8.

C. Four-pole tents

1. *WHYMPER* tent. Four poles in two pairs, carried in sleeves in the canvas at each end of tent, shouldered to take loop or flap of canvas, and crossed at top. Ground-sheet sewn in and turned up in front. Principal guy sewn into ridge and made fast to pegs back and front in line of ridge; subsidiary side guys for stability and to keep tent from sagging. First made to designs by Edward Whymper in 1892.
M.E.E. pattern 1936, called *Special A tents* by makers (Camp and Sports), $7 \times 5 \times 4\frac{1}{2}$; eave 1; outside skirting 1; khaki Jaqua; $19\frac{3}{4}$ lb.; £9 3*s*. 9*d*.; $6\frac{1}{2} \times 3\frac{3}{4} \times 3\frac{3}{4}$; $15\frac{1}{2}$ lb.; £7 19*s*. 3*d*.
Whymper (Edgington), $7 \times 7 \times 6\frac{1}{4}$; Willesden canvas; 35 lb.; $7 \times 5 \times 5$; 21 lb.; $6\frac{1}{2} \times 4 \times 4$; 14 lb.
Croft tent (Thomas Black), similar, but extended front and back to hexagonal ground-plan (see diagram), $5\frac{3}{4} \times 2 \times 2 \times 4\frac{1}{2}$; light sailcloth; duraluminium poles.
Yak tent (Robert Burns). Side of Whymper tent cut into four planes, one through ridge, two through poles, one vertical, stretched by guy ropes from two points of intersection, to give more head-room. Poles fitting over inverted Y-piece cast aluminium, whose tubular stem $1\frac{1}{2}$ inch carried spindle of revolving leather cowl for ventilation. Sleeve opening at each end, for pitching end to end. Made for M.E.E. 1936. $7 \times 4\frac{1}{2} \times 4\frac{1}{2}$; 18 lb.; and $7 \times 4 \times 4$; 11 lb.; £10.

2. *MEADE* tent: the Whymper tent with a fly. Originally the crossed poles were given a second shoulder to carry the eyelets of a fly. Later a ridge pole was laid in the crutch formed by the tent poles crossing, and the fly laid upon it. Small Whymper tents without fly have become known as Meade tents, but it seems better to preserve the distinction between the two.

3. *PYRAMID* tent, the oldest type of Arctic tent, much improved by being made double. Four poles are laced together at the apex to a canvas cap, or screwed to hinged block, to make the frame. An inner tent with sewn-in ground-sheet is tied to the four poles; an outer tent is placed complete over the poles, and held down by weighting a broad skirting, and by guys also in heavy weather. Sleeve openings in each tent passed one into the other. A piece of 1-inch (internal) rubber tubing with wooden stopper passes through front of both tents near apex, for ventilation; a similar tube passed through the tied-up sleeve opening when Primus is burning in closed tent. (Watkins, B.A.A.R.E., 1930.)

Alternatively, the poles are carried in sleeves in the outer tent, and rolled up with them; the inner tent taped to the poles when required. (Glen, North East Land, 1935–36.)

Pyramid tent (Camp and Sports), for M.E.E. 1936. Khaki Jacqua outer, $7\frac{1}{2} \times 9 \times 7\frac{1}{2}$; Linenette inner, $6\frac{1}{2} \times 8 \times 6\frac{1}{2}$; with Groymac ground-sheet; 39 lb.; £16 13*s*. 6*d*.

Pyramid tent (Thomas Black), sleeve entrance; inner, $7 \times 6\frac{1}{2} \times 5\frac{3}{4}$; 40 lb.

D. Dome tents

Eight quadrantal ribs fit into central metal cap, or hinged to wooden block, with ventilator shaft. The inner hemispherical tent in eight gores, with sewn-in ground-sheet or alternatively inner skirt, is suspended from the rods by tapes: an outer hemispherical tent is placed complete over the framework, and held down by weighting a wide skirt of Willesden canvas. Also guys for heavy weather.

First used by Watkins 1930 for Ice Cap Station with approach by snow tunnel under floor, and completely covered with a snow house (igloo) built over it. Adopted for M.E.E. Camps III and IV, 1933 and 1936, with door of inner tent closed by tapes and zipp fastener, of outer by toggles and cord lacing.

Dome tent (Thomas Black), for North East Land Expedition 1935–36.

Dome tent (Camp and Sports), for M.E.E. 1936. Outer khaki Jaqua, 10 diameter $\times 6\frac{1}{2}$; inner Linenette; 9×6; 75 lb.; £37 5*s*. Larger size 13×7 (outer), £45 4*s*. 9*d*.

The Central Asian yurt is a somewhat similar domed tent on a

frame, but raised on poles with vertical walls. Roomy and comfortable, and worth study and imitation.

MATERIALS FOR TENTS AND WINDPROOF CLOTHING

In choosing material one must take into account weight per square yard, strength to resist strains and maintain shape, resistance to penetration of rain, snow, and wind, durability in sun or in wet, appearance and cost. Many trade descriptions—duck, drill, cambric —are used indiscriminately; and proprietary names, as Grenfell cloth or Jaqua, are not descriptive.

Nearly all tent and windproof fabric is cotton, and the quality of the "grey" cloth (the natural cream or white colour before processing) depends upon the material (Egyptian, Sea-island, etc.), upon the "count" (so many hanks of 840 yards to the pound) single or twofold, upon the closeness of weave (reed and pick, that is, threads per inch in warp and weft), and upon style of weave (plain, twill of various kinds, and others).

The weight of the cloth is given, or should be, in ounces per square yard, not per yard run; or it may be calculated from the count, which is expressed thus:

40s is single yarn $40 \times 840 = 33{,}600$ yards to the pound.

2/80s is twofold yarn equal in weight to 40s, but closer spun and stronger.

The spun yarn may be dyed, finished, and treated in various ways before it is woven, and the woven cloth proofed against rain or rot by processes sometimes affecting its weight and strength and wear. Windproofness depends mainly on closeness of weave. Rainproofness is a vague quality. A wet tent untouched may be quite tight, but a touch on the inner side of wet canvas breaks the surface-tension of the small drops showing through, and starts a leak. Similarly a rainproof coat will leak first in the folds where the fabric is rubbed. To keep out fine dry driven snow at high altitudes a tent must be windproof rather than rainproof.

Fabrics for wear are made partially waterproof by treating the dyed cloth with a mixture of waxes dissolved in benzine. Washing and cleaning may destroy this proofing. Waterproofing with drying oils or with rubber is more complete: makes fabrics suitable for standing about in, but not for hard work or marching, since they keep perspiration in as well as rain out.

Stouter fabrics for tents and ground-sheets are usually proofed by a copper-ammonia process (such as Willesden proofing) which gives a fine green colour to undyed canvas, and is proof against mildew and white ants as well as rain, but does not always stand fierce sun. Fabric often dyed khaki after this proofing.

The strength of a cloth may be the same each way, but often the warp is stronger than the weft, since sails, tents, and clothing have usually unequal strains to bear, and are cut so that the warp bears the greater. The strength may be tested by laboratory determinations of the strain which breaks a strip held in jaws, or which tears out a tongue cut in the cloth; the durability tested by prolonged rubbing; the windproofness by microphotographs against a light, or more simply by straining a piece over the mouth and blowing; the waterproofness (though with reservations) by measuring the head of water which percolates.

In plain weaving the alternate threads of the warp are raised and depressed so that the shuttle passes alternately above and below a thread. The varieties of weave are obtained by holding up the warp threads cyclically for more than one throw of the shuttle. The details of weave of a cloth are not usually obtainable; we are the more indebted to those firms who have very kindly given or obtained for use in this book the description of fabrics which have been supplied to recent expeditions.

Messrs. Thomas Black and Sons (Greenock) Ltd., 25 Cathcart Street, Greenock, made the outer Dome tents used on Ellesmere Land and Northeast Land expeditions of a cloth by Messrs. Joshua Hoyle, 540 DK, called by Black D2: plain weave, green Willesden proofed, warp 66 weft 54 threads per inch, 8 oz. per square yard, so count about 10s or 2/20s. Ground-sheets of same cloth oil- and rot-proofed by Messrs. Inglis of Dundee. For pyramid and Croft tents they used two fine sailcloths of Egyptian cotton by M. C. Thomson and Co., Ltd., of Arbroath. No. 8 was a plain weave of 88 by 90 threads both twofold, $5\frac{3}{4}$ oz., so count about 2/40s 2/50s, weight after proofing $5\frac{7}{8}$ oz. Cloth No. 10 was of 100 threads twofold by 127 single, $3\frac{1}{2}$ oz., so count about 2/100s 40s.

Messrs. R. Burns, Ltd., of Hanover Mill, Buxton Street, Manchester 1, made the Yak tents for the Mount Everest Expedition 1936 of three cloths: the heaviest a Willesden proofed Duck of 44 by 42 threads twofold, weight 12 oz., count 2/10s 2/10s; the second,

making tents 4 lb. lighter, a Willesden-proofed brown cloth of 100 by 90 threads, count 2/60s 2/60s, so weight about 4½ oz.; the third of Grenfell cloth, for which see below. For the Nanda Devi Expedition of 1936 they made Yak tents of brown Willesden-proofed cambric of single Sea Island cotton, 128 by 144 threads, count 100s, weight 3 oz., though the figures would seem to give 2 oz. This very light cloth was said to be blizzard- and water-proof.

Messrs. Camp and Sports Co-operators, Ltd., of 21 Newgate Street, London, E.C.1, made Pyramid tents for the M.E.E. 1936 of Khaki Jaqua for outer and Linenette for inner with Groymac ground-sheets. Jaqua is a plain weave 90 by 80 copper-ammonia proofed and dyed khaki, weight 7 oz. proofed, count 2/40s 2/40s which makes 5¾ oz. unproofed. Linenette is plain weave 90 by 108, weight 3·4 oz., count 40s 50s. Groymac is Linenette copper-ammonia proofed and oiled, which brings its weight up to 7¾ oz. For very light summer sledging tents for East Greenland they have used Kampette, a plain weave 125 by 125, weight 2½ oz., count 70s 70s.

Messrs. Benjamin Edgington of King William House, Eastcheap, E.C.3, use for their Whymper tents a Willesden proofed plain weave 70 by 54 both twofold, weighing 7¾ oz.; and for their Mummery tents a Willesden proofed 2 by 2 twill 50 by 104 single, weight 6¾ oz.

From the figures for weave and count it is simple to calculate the weight per square yard of the fabric as it would be woven without any dressing of the yarn or after-treatment for proofing. Alternatively one may by trial discover the approximate count from the weight as has been done once or twice above, when the actual figures are not available. The feel of the fabric, more important for clothing than for tents, depends much upon finishing processes.

For windproof clothing the two materials most often used lately by British expeditions are Grenfell cloth and Wordie cloth.

Messrs. Baxter, Woodhouse, and Taylor, Ltd., of 17 Sackville Street, Manchester 1, make the Grenfell cloth, which is much stronger on the warp than on the weft, finished very clean and smooth, and so rather chilly to the touch. Twill weave, 2 over 1 under, 198 by 96, weight 5·1 oz., count 2/80s 2/80s.

Messrs. Wm. Fison and Co., Ltd. of Greenholme Mills, Burley-in-Wharfedale, Yorkshire, weave the Wordie cloth to a specification prepared for him by the late Mr. Howard Priestman. Woven only to order and stocked by S. Morgan, successor to Arthur Bennett,

38 Trumpington Street, Cambridge. Twill 2 over 2 under, threads 144 by 144, weight 5 oz., count 2/80s by 2/80s; dyed greenish brown and wax-proofed. Warm and soft to the touch and wears well.

Probably the plain weave sailcloths such as Jaqua or Black's No. 8, if wax-proofed, would make good and inexpensive windproofs.

POLAR CAMPS

The base will usually have a hut with frames made in sections numbered and marked with patches of colour where they go together. Double matchboard walls are nailed on and filled with moss or sawdust, or preferably insulated with aluminium foil fabric; windows and floor are double, the roof of tarred felt wired down to boulders.

"Returning through the rain to the new base hut which three weeks before had been a bare and cheerless barn, we found instead a warm home, lighted with electricity, an efficient staff of Eskimos, and Lemon, the *maître d'hôtel* who had done all this alone, calling for food in a strange language and handing round glasses of hot punch. In time we all learned to speak Eskimo more or less, but it was Lemon who had discovered that first most difficult phrase, 'what is your word for this?'" *J. M. S. on Lemon.* 80.559.

"The hut was 30 feet long by 20 feet wide. The walls were double, enclosing a 3-inch air space, while outside tarred paper covered the planking as an added protection. It would have been better however if the planking had also been covered with some extra insulating material such as tinfoil. Inside was the main living-room, a bedroom with nine bunks, a small larder, and a little hall. The stove, in one corner of the living-room, burned coal or driftwood, but it was inadequate to heat the whole hut under cold weather conditions. Small portable oil stoves were also taken, but the paraffin available for these was unfortunately limited. Overhead was a large loft invaluable for storing equipment and personal belongings. Its ceiling however was only single, causing hoar frost to collect thickly upon the wood, and also making it a perpetual reservoir of cold. Outside were two dog houses, and a second tiny hut, 80 yards distant from the base, used for the ionosphere research. On the southern wall of the base hut was the engine room, housing the small Petter generating unit, and an Austin-7, used with the large transmitter." *Glen. North East Land.* 90.201.

For a distant permanent station, as on an ice-cap, use the double dome tent; with inside diameter 8 feet it holds two men with gear and stores for a long stay. An igloo may be build over it, with other igloos near by and communicating tunnels. The entrance to the main tent is by tunnel to provide ventilation without draught; can easily be regulated. An emergency exit should be made through an adjoining igloo. For description and drawings of Glen's ice-cap station in North East Land see *Geogr. Jour.* 90.213–17.

Domed tents have rigidity from the frame, and require guys only against heavy wind, and to keep canvas from sagging. But difficult to pitch on hard uneven ground. The outer cover must have a 3-foot snow-flap, and if any opening must be unbroken for height of at least 6 inches round feet of frame to prevent it spreading. Inner tent is tied with tapes to the frame, leaving about 6 inches space between it and outer. Inner tent has loops and tapes, preferably in bright colours, for drying clothes.

"To build a snow house is not difficult: in fact I built my first without previously seeing it done; but to build with the speed and neatness of an Eskimo who has done it from boyhood is a very different matter. The method has been well described by Dr. Stefansson in 'Hunters of the Great North.' He does not however made it clear that all the snow blocks are obtained from inside the snow house, so that a third of the wall is made by the removal of the blocks; a good builder will also have enough snow left inside for the bed. According to Dr. Mathieson the Greenlanders obtain the snow from the outside, and perhaps this is true of Dr. Stefansson's Mackenzie River natives. For a beginning at least, a saw is easier and quicker than a knife for cutting blocks, and many of the Eskimos on Southampton Island now use it. Some of the natives can build a house in about half an hour, while it would take me an hour and a half, and I therefore only used one when I was not expecting to move next day. As it is unnecessary to build a snow house bigger for two than for one, two people travelling together would probably find it best to use it entirely and thus save the weight of a tent as well as having the extra comfort. It is quite possible to build and use a snow house for one or two nights even with temperatures above freezing. Also in the fall if there is only an inch or two of snow and the temperature is above freezing, sufficient snow for a small house can soon be collected by rolling snowballs, and cutting them into blocks. During the winter astronomical sights were taken either by removing a block from the snow house or through a sleeve opening in the top of the tent." *Manning. Southampton Island.* 88.234.

"In the beginning of November the rising snow-level finally swamped the roof of the tent. The ventilating cowl was buried, but after one unpleasant experience of the effects of carbon monoxide poisoning, a new ventilator was contrived, by soldering together a number of bottomless Quaker Oat tins. This proved admirable despite the fact that the depth of snow above the tent roof was such by the following March that the ventilator eventually reached a length of 6 feet. The tent fabric bore this additional snow cover without any signs of distress, but the tubular brass joints in the middle of the poles were inadequate. In consequence, the roof lost its domed shape, sinking to such an extent that in four months its height decreased from 8 feet to 5 feet. In order to prevent complete collapse, a central support was improvised from floor boards put together in the shape of a T-girder."

Glen. North East Land. 90.216.

Shackleton designed for his 1914 expedition a four-man and a less

successful eight-man dome tent, shaped like a sand-dune and cut at the door so that eddying wind kept it free from snow. One man could pitch it in a blizzard; but the hoops had no joints, so the folded tent was cumbersome. Otherwise it would perhaps be the best of all tents for sledging.

For severe winter travel the Pyramid tent is standard. Watkins fitted the four poles into sleeves of a canvas cap, with a pin through each, but later experience suggests hingeing to a central wooden block. Attach the inner tent by tapes to points where guy ropes sewn on outer tent, as well as to the poles. If ground-sheet not sewn in, whole tent can be rolled up more easily for sledging. Outer tent has 2-foot snow-flap and a 12-inch strip of oiled fabric added round bottom to keep the heaped snow from soaking through. Liable to tear if weighted with stones. Guy ropes sewn in just above one-third of the way from middle of base to apex. Carry the tent in a bag to prevent sledge boxes chafing canvas. Very easily dismantled, and lashed on sledge ready for instant erection if caught in blizzard.

Heavy ground-sheet necessary; if sewn in ensures stability in a blizzard, but is left up in the air if poles cannot be driven into hard surface; and snow carried in cannot easily be brushed out, nor can snow for pot be scooped in underside of tent in bad weather. Loose ground-sheet should be 18 inches bigger than tent floor. Except in sledging at high altitudes, where there is danger from Primus poisoning, ventilators not so important. Height of tent advantageous for drying clothes in warm air collecting at apex: much better for this than tent with ridge. Minimum size of outer tent $7 \times 6 \times 5\frac{3}{4}$ for two, and $7\frac{1}{2} \times 6\frac{1}{2} \times 6$ for three.

"Pyramid tents manufactured by Messrs. Camp and Sports were used and proved excellent: a coastal party in Spitsbergen however requires a rainproof tent. The temperatures were not so low as to necessitate the use of *finnesko* and the hairless Lapp-boot would be better for camp work."

Glen. Spitsbergen. 84.129.

"Against the extra weight of carrying a tent must be set the length of time necessary to build an iglu for each night's camp, ... On the other hand, when sledging with Eskimo, . . . at least one man may have driven so far ahead that the camp is sometimes half finished by the time the European members of the party arrive. . . . the most skilful iglu builders are to be found in Baffin Land. . . . If the iglu is to be used for any length of time, it is possible by pegging a canvas or sealskin lining inside the roof to raise the temperature of the iglu to any height desired, without melting it. . . .

There is in an iglu none of the flapping which is so trying in a tent during a blizzard, nor can the finished house blow away."

E. Shackleton. Ellesmere Land. 87.436.

Andrew Croft was well content with his modification of Whymper tent after year's experience in North East Land. His duraluminium poles were hinged, not socketed. Main guy anchored to ration boxes, with lighter guys for extension attached to wooden slide on main guy, as in diagram. Crowfoot guys at each side to ration boxes. Light-weight inner tent taped to outer in severe weather. Two-foot sleeve entrance and tube ventilator opposite. Heavy proofed groundsheet sewn in, considerably larger than ground plan of tent, with 18-inch square hole near door, for brushing out snow, covered with flap. Snow flap 18 inches. Weight only 14 lb. Can be pitched anywhere, and steady if no snow for piling on flaps. Clothes line along ridge. Low for drying clothes, but lowness advantage in heavy wind.

Arctic tents are pitched with entrance downwind, though it will be drifted up. Tents should stand as close as possible together for easy communication.

For summer travelling the Mummery tent gives most room for weight, but does not stand heavy wind, and takes longer to pitch than single Pyramid. Tent $6\frac{1}{2} \times 4 \times 4$ will hold two men, and $6\frac{1}{2} \times 5 \times 5$ holds three. Can be made very light for back-packing. Originally designed to use ice-axes as poles, but modern ice-axe too short: ski-sticks sufficient; but separate poles better unless tent is mere shelter for a night.

"Tents were the ordinary wall or cottage shape (Mummery tent), made of specially light sleeping-bag material (Kampette) with sleeve opening and groundsheet. For support we used light telescopic aluminium poles or ski sticks with lengthening pieces. The weight of tent complete with poles was $4\frac{3}{4}$ lbs." *Courtauld. E. Greenland.* 88.207.

"Owing to these fluctuations, it is somewhat difficult to adjust clothes and sleeping arrangements to give anything like constant comfort. There were three Whymper tents. Two zoologists inhabited one of them, and were a subject of envy by other members sleeping three in a tent, until the atmosphere was sampled after a day's dissecting of birds or lemmings at a temperature of 70° F. The tents were fitted with mosquito netting over the entrance and vent-holes. In hot weather the ventilator hole was too small; it should be made about 10 inches wide. At the kind suggestion of Miss Nordstrom, *rachkes* were used and proved a great blessing in hot weather. These were tents made of strong mosquito netting, the length of a man, and could be hung between two birch trees, the sides being tucked underneath the sleeper. In cold weather they could not be used, and even after hot days

were often cold at night. They were a convenient refuge from mosquitoes for any one working on collections, etc., and weighed very little."

O.U.E.C.3. Lapland.

The best conditions for comfort in Polar camps are calm weather and a temperature about zero F.: the snow is crusted and hard; sledges run easily; drift snow does not stick; and everything is dry. There is no question of being cold and yet one can wear all the cold-weather clothes which are comfortable because they fit loosely.

Below zero the cold becomes increasingly painful. Metal bites and blisters, and hoar frost becomes a nuisance everywhere on instruments, on the face, in the clothes, especially round the feet and hands, and inside the tent and sleeping-bag. Also the sledging surface deteriorates. Frost-bite, particularly of course in a wind, becomes much more likely.

Above zero the snow is often soft; falling or drifting snow sticks or even melts on windproofs and soaks through; and in a blizzard at about 20° F. any facial hair becomes completely iced up. This is unpleasant, and in a tent bad, because it adds to the amount of water inside, but this cake of ice undoubtedly keeps one's chin warm. In cold weather keep the area round the mouth cut close.

About 20° F. the sewn-in ground-sheet becomes a nuisance, for in a blizzard it is impossible to get into the tent with windproofs clear of snow, which then melts on to the ground-sheet and/or sleeping-bags. Turn back the front of a loose ground-sheet, and shake windproofs on the snow in front; then turn the sheet down again and hang up the windproofs to dry. Probably the best ground-sheet would be sewn round the back and sides to within a foot or two of the front, and then with a flap longer than this. If one knows that the temperature will stay below 10° then a sewn-in ground-sheet is all right, for in the worst blizzard windproofs will not be very much snowed up, and if there is a small hole in the ground-sheet the snow can be swept into it before it melts. All this snow brushing has to be done with a small stiff brush before the Primus is lit. A sewn-in ground-sheet is warmer and safer, for the tent cannot blow away.—*From note by J. W. Wright.*

MOUNTAIN CAMPS

On long mountain expeditions be as comfortable as you can for as long as you can; eventually you must leave heavy camps below

and travel light above. For lower camps therefore take a large Meade, say 7×7, with extended ridge pole and fly; for higher Whympers of diminishing sizes and weights, with eaves, which not only protect from rain the lower part of the tent, against which you sleep, but distributes evenly the stress of the side guys and keep the tent from flapping.

High-altitude snow is very fine and drives right through anything light except the finest windproof. Grenfell and Jaqua cloths are good. The sleeve opening of the Arctic has been tried on mountains but found exhausting at great altitudes. The small metal zipp fastener has been suspect as too fragile, but was successful on Mount Everest in 1936. It is understood that I.C.I. propose to make them with larger elements of synthetic resin. This fastener is weak against cross strains, and tent flaps must be cut full. Ventilators appear to be more necessary at high altitudes than in the Arctic: a flat curtain pulled up and down by cords in a canvas frame round the opening worked well in 1936 on the Whymper tents made by Camp and Sports for the M.E.E. The smaller Whymper $6\frac{1}{2}\times3\frac{3}{4}\times3\frac{3}{4}$ held two comfortably and three not; the larger $7\times5\times4\frac{1}{2}$ held three, and four or even five at a stretch. Poles with blunt ends in canvas sleeves at apex. Door with one vertical and two horizontal zipp fasteners, and flaps in case of failure. The revolving cowl in the peak of other tents was voted an inconvenient gadget, difficult to pack and easily damaged. Another gadget disapproved was the V-piece of aluminium tube to take the poles at the apex; it impeded adapting width of tent to a narrow built-up platform. Likewise on Nanda Devi the Logan tent wanted too wide a platform, and not taut in heavy wind, but gave good accommodation for weight.

In conditions less severe a Mummery tent $6\times4\times3$ with wall $1\frac{1}{2}$ and snow-flap 9 inches, sewn in ground-sheet, aluminium poles, eight guys, sleeps two comfortably, three at a pinch, and may weigh less than 5 lb.

For a high advanced base the M.E.E. adopted the Arctic dome tent, the inner hung to frame by rope loops with ring and dog-clip instead of tapes. Loose ground-sheet, broad snow-flaps, mica window (fragile). Inner tent closed with zipp fastener; outer by double flap fastened with rope loops and toggles. They took also in 1936 Pyramid tents for porters at high camps with double sleeve

openings which rolled up together when open. Poles can be separated in their sleeves and bundled up for portage.

"Not many innovations were made in equipment and stores. The principal was perhaps a new kind of tent combining the properties of an Asiatic *yurt* and of the arctic tent used by the late Mr. Watkins in Greenland. This was of octagonal shape and double skinned. It proved of the greatest value in bad weather conditions. Three such tents were taken."

Ruttledge. M.E.E. 1933. 83.2.

"The R.G.S. presented three Everest pattern Whymper tents, with double flies [*i.e.* tent and fly]. These were very strong and light, and withstood some very high winds; they were made by Messrs. Benjamin Edgington. Each weighed 58 lbs. complete with poles, metal pegs, and bag. At the end of the expedition they were almost as good as new." [Apparently the tent $7 \times 7 \times 6\frac{1}{4}$ with extended fly: Meade, not Whymper.] *Mason. Shaksgam.*

"The party was to be entirely cut off from civilization for a period of nearly three months, mostly in severe atmospheric conditions. In order to secure proper shelter for all altitudes, three kinds of tents were used: one large (18×12 feet) tent for working bases in lower altitudes; three small army tents for two persons each for intermediate and exploration camps; and three small very light silk tents for two, specially designed with insulating sheet of air between the double walls and floors made of balloon material. The total weight of each silk tent with aluminium pegs and posts did not exceed 2·8 kg."

Daszynski. Andes. 84.215.

DESERT CAMPS

One can be comfortable in a desert with little equipment, and comfort is increased by simplification, and reduction in the number of gadgets to be packed, unpacked, and looked after. Tents are rarely necessary, unless one stays long in one place for scientific work, and shelter from wind and sun during the day is essential; they are of little advantage at night. For a camp of several days, or as shelter from a shower of rain a light sheet of canvas stretched between two cars is an efficient substitute.

Protection may be wanted at night against dew, creeping insects, mosquitoes, and hard stones beneath one's body in bed. In the interior of true waterless deserts none of the first three exist and the last will be avoided by choosing a camp site with sufficient sand-drift sleeping accommodation. A light canvas valise of the Wolseley pattern will keep out the dew; but care should be taken that the canvas cover extends high enough to be pulled over one's head and pillow if necessary. Many valises are faulty in this respect. If creeping

things are feared a camp bed must be taken, but it is awkward and heavy, and more draughty than a well-chosen sand-drift.

Major R. E. Bagnold.

Tents are not required in China proper, where accommodation is nearly everywhere available in inns or temples. In South and Central China especially there is seldom room to pitch a tent owing to the congestion of buildings in towns and villages and the closeness of cultivation outside. The only exception would be in the case of shooting or natural history expeditions in the wilder mountain regions. But in any case due inquiry should be made before encumbering oneself with tents which will probably prove unnecessary.

In Chinese Turkistan also the traveller along the main roads has no need to carry tents; though the inn accommodation may be very primitive and there is more room (than in China) to camp if one wants to.

In China's frontier regions, Eastern Tibet and Inner and Outer Mongolia, tents are indispensable. The most useful type is the small native travelling tent as used all over Mongolia. These tents, felt lined for winter use, can be obtained in any Chinese frontier town such as Suiyuan (Kwei-hwa-ch'eng). They can be fitted with small portable native stoves. *Sir Eric Teichman.*

It is often possible in China to stay with missionaries. One should give about two dollars per night for board and lodging, and allow the missionaries' servants to make arrangements for your transport. To travel thus in China doing scientific work costs say five to six dollars per day with two donkeys and a man.

"Five light poles and a waterproof half-tent just covering a camp bed, about 18 inches off the ground, gives privacy to dress in and protects the bed when it rains: quite sufficient for a trek where one usually sleeps in villages. In regions where every piece of baggage is a temptation to the tribesmen it is better to travel without a tent, which is always rather conspicuous."

Freya Stark.

"I had not brought a tent with me from considerations of weight. The cold at night was bearable; sleeping out of doors in temperatures usually falling to 55° F. I slept in all my clothing in the manner of my companions, but plus three blankets, which the poor shivering wretches were without. My routine was to make a traverse by day and adjust it by latitudes taken by night." *Thomas. Rub' al Khali.* 78.216.

"In Sinkiang good tents are essential, and cannot be obtained in the country. Take one for the kit, and one big enough to hold all the caravan men." *Schomberg.*

For leisurely travel and scientific work in desert consider the merits of huts, as used increasingly by Palestine Survey Department in place of tents. The walls are in upper and lower sections of 6-ply wood, framed, with diagonal strut inside; windows some of Windolite, others with fly-proof wire: all sections clamped to frame; corrugated iron roof covered with grass or leaves in hot weather, interior canvas ceiling. Wood ground plate. Suitable for lorry or horse-drawn transport, but less for camels. Full specification and drawings deposited by Colonel Salmon at R.G.S.

TROPICAL CAMPS

Tropical Africa is no place for a traveller to roll himself in a blanket and lie out under the stars. Health requires a good tent of green rot-proof and damp-proof canvas and about 10 feet × 8 feet as a minimum, with outer fly extended to about 9 inches from ground on each side and about 4 feet in front to form verandah under which to work and eat; semi-circular bathroom at back is a great comfort; ground-sheet of green canvas with brass eyelets at intervals along four sides. Canvas pockets inside the tent and fixed back with attached hook on one tent-pole for hanging clothes. Tent pegs of hard wood, two mallets each with iron band shrunk on the end. Strips of strong tape sewn along inside of tent at convenient places to attach mosquito nets. Small eyelets inserted in flies, two a side about one-third distance from outer edge to reach pole for extra guys in a gale to be passed laterally over the fly to check its flapping and avoid it being torn off. One 10 × 8 tent complete with bed packs into two canvas valises, each load for one porter.

For motor travel with lorry half a tent fixed on each side provides shelter by day and sleeping accommodation; economizes the transport somewhat but not so comfortable as complete tent. Better to have canvas wagon hood over lorry body for night and temporary shelter by day with ground-sheet.

The sides of box body are sometimes made of strong wire net to be let down at night horizontal forming spring mattresses. Canvas covering can be made long enough to extend to the ground, where it is laid down forming sloping side of tent. *C. W. Hobley.*

Tropical tents should open high all round so that they can become either a shelter roof, or a wind shelter, or be closed completely.

Single-fly tents are too hot and will keep out neither sun nor rain. Pay special attention to fitting mosquito nets.

Useful shelters may be made of a sheet hung on thornscrub or over a pole slung between trees for shade.

When camping in tropical rain-forest, as in the New Hebrides or S.W. Ceylon, site the camp in a clearing as large as possible, and to catch the prevailing wind. If a tent is used the fly should extend well beyond the end to make a verandah, preferably facing east. Dig a deep ditch round the tent to carry away all water. If the camp is on a slope, dig another ditch above the tent to divert the water draining from higher ground. Tent pegs should be extra long for sodden ground. A ground-sheet is necessary; small tents away from the base camp should have ground-sheets sewn in.

In general, prefer native-built houses to tents, as they give a restful feeling of protection in bad weather. It is generally as cheap to have a thatched house built as to buy and transport a tent. Thatch with palm leaves or local substitutes (*e.g.* the leaves of the Euphorbiaceous *Agriostachys longifolia*, or *beru*, in Ceylon). These native houses lack light for scientific work, but it is easy to make laboratory shelters nearly open on one side, with their backs to the prevailing wind, convenient except in very bad weather. *J. R. Baker.*

In many tropical countries it is also unnecessary to carry tents on the march, since excellent waterproof shelters may be quickly constructed from leaves, on a frame of saplings, bamboos, etc. Cut uprights with a fork at the top, lay beams for ridges and eaves in these forks, bend bamboos over for rafters, and thatch. Excellent lean-to shelters, or more ambitious structures, can be built very quickly by native carriers wherever there is space, as on river banks.

"We had a riverside house built by Dyaks, of logs, roofed and walled with leaves. This was a delightful place, but had to be abandoned when the north-east monsoon and its heavy rains arrived; the river rose 30 feet in three days and the floods reached the roof. In the jungle we normally lived in tents, and in spite of mosquitoes, sandflies, ants, and other unpleasant insects, made ourselves fairly comfortable. Occasionally leaf shelters were all we had for a night or two. Our Dyaks were experts at building camps. A party of a dozen could in two hours clear a site and have the tent up, built on a raised platform of logs with a floor of strips of bark, with tables and chairs of logs, bark, and rotan, and an excellent bathhouse of leaves. If the nearest stream were good and the camp to be used for any length of time, they made a bathing pool."

Bagot. Johore. 83.208.

"The 'tents' erected by the Indians with incredible speed consisted of wooden frames over which heavy tarpaulins were stretched. Two or three stout verticals about 12 feet high were first cut out of the surrounding bush, one end being sharpened and planted in the earth, the other formed into a rough sort of clothes-line fork by lopping off just above the spring of a largish branch. Along these forks was next laid a straight heavy ridge-pole of about 3 inches diameter, and along this lengthwise the tarpaulins, stretched tight by tying them to a set of slenderer uprights planted in the ground in such a way as to act as springs thrust outwards from the centre and heavily overlapped with the next. Being only 6–8 feet long, these uprights also gave the required pitch." *O.U.E.C.2. British Guiana.*

"However, from here until we reached Bani Shanqul it rained every night and on occasions by day. This affected us very nearly, as we had reduced our kit to a minimum, having now no coats or change of raiment except stockings and only one eight-by-six foot waterproof sheet to serve as a bivouac. This, carefully erected each evening with regard to the wind and slope of the ground, enabled us to reach Mendi without getting wet at night."

Dunlop. W. Ethiopia. 89.516.

CHAPTER IV. CAMP FURNITURE

BEDS

MOST people consider that a camp bed should if possible be taken; that one sleeps much better in bed, and that it is therefore essential for keeping fit. It may be possible to lay one's bedding on the *k'ang* (sleeping platform) of a Chinese inn, but a folding bed of the right type, light, strong, and portable, will pay for its carriage many times over in comfort and protection against insects. Others consider that a bed is not a permanent comfort; that soon one does not notice the want of it; and that on a mountaineering expedition if you don't sleep on the floor from the start you won't sleep in a high camp.

The commonest form of bed is the X pattern with many joints, and the Gold Medal pattern (Edgington's B.E.) may be preferred, if the canvas is not stretched too tight. Neither is convenient on uneven stony ground, and a pattern such as Edgington's Hounsfield is well spoken of. The side rods are springy steel, folding in half; the supports are four W-shaped steel springs with rubber feet. In deserts one may often sleep out on a bed fitted with poles for mosquito nets with a light cloth top against dew.

If sleeping on the ground, excavate holes for hip and shoulders, or arrange foundation of stones to give the same effect.

BEDDING

A horsehair mattress to fit the bed is good but bulky; Kapok is lighter and comfortable; the Li-lo rubber-fabric mattress still lighter, and comfortable if not too much inflated; good for summer conditions in the Arctic, but cold in winter. For sleeping on the ground a Sorbo rubber sheet, of the kind that does not break up in cold, is excellent: 3 by 2 feet large enough. But rubber often causes condensation and damp. Without a mattress one wants as much bedding below as above. For tropics light woollen sheets are comfortable, easily packed, and do not show dirt. One layer of brown paper may do for a bottom blanket, but a good thick dhurry is better, serving also as a rug for the midday halt, and comfortable across the saddle. A leather coat with mercerized cotton lining serves well for pillow and pillowcase. Chinese quilts (*p'u k'ai*) serve as light mattresses or eiderdowns.

Have separate canvas bags for all bedding, so that a servant can pack or unpack without waiting for other things; but remember the risk of vermin from carriers. Hot sun rids sheets and blankets of vermin, but bags cannot be kept sweet. Bags and bedding attract snakes and scorpions. A piece of oilskin for ground-sheet keeps away bugs and lice and makes a good wrapping for bedding: useful in inns and trains as well as camp.

"A sleeping sack on a camp bed. Take sheets for greater comfort: one always needs extra linen for dressings, bandages, etc., and one can tear strips off the sheets when the need arises, and enjoy them meanwhile."

Freya Stark.

SLEEPING-BAGS

Sleeping-bags vary much, particularly in the method of dividing the bag into small sections to keep the down in place. A single layer quilted leaves a grid of lines unprotected; avoid this either by multiple bags or a single bag with cellular divisions, not quilted. Fill with eiderdown, still obtainable but expensive, or cheaper but less efficient, "fine down." For winter in arctic 2 to $2\frac{1}{2}$ lb. of eiderdown required; for summer $1\frac{1}{2}$; covering light and downproof.

A wool sheet 30 by 20 inches under the sleeping-bag takes condensation by cold of ice or snow below ground-sheet.

Reindeer bags stand longest and roughest use if skins are of right sex killed at the right time; but they moult and are difficult to dry. Weight 8 to 11 lb. Must be chosen by some one of experience, and no use economizing over them. Bear skins soon fall to pieces.

Blanket (*e.g.* Jaeger) bags are not warm enough for arctic, but good for desert. Tropical sleeping-bags are more for dryness than warmth: light, waterproof, with zipp fasteners across top and down side, recommended by some; easily put out of action but last well with care. When too hot to sleep in a bag use it for mattress.

"During such periods of enforced and prolonged inaction the deerskin rugs providing an insulation between our eiderdown sleeping-bags and the ice beneath used to become very wet with condensation. On the evening of the fourth day, while we were making an effort to dry them by hanging them up in the peak of the tent and burning two Primus stoves underneath them, the weather suddenly cleared. We went outside to make a theodolite observation and to take photographs. We rolled up the sleeping-bags and pushed them to the back of the tent; the Primuses were pumped up and left alight in the middle of the floor, well clear of everything.

Some time later somebody smelt burning, and saw smoke belching forth.

It was only a matter of seconds before the fire was extinguished, but only a few seconds more would have been sufficient to cause a disaster. A few holes were burnt in the canvas, which was badly scorched. The only explanation of the origin of the fire is that the heat swelled the down inside one of the sleeping-bags, causing it to capsize over the Primuses."

Lindsay. Greenland. 85.400.

"We had expected cold weather on the journey [November] and had gone prepared for it. Actually we had not one low temperature. About -40° Fahrenheit was the lowest on the journey, so that we never had to trouble to build snow houses and could use single down sleeping-bags, weighing $2\frac{1}{2}$ lb."

Watkins. B.A.A.R.E. 79.360.

"Sleeping-bags were specially light double down, and a small blanket (2×3 feet) was provided to lie on and take the condensation, which it did very well."
Courtauld. E. Greenland. 88.207.

"Kapok fibre-filled sleeping-bags were also used, but proved hardly warm enough in late July and August. The sleeping kit of each man (sleeping-bag, rachke, and ground-sheet) weighed about $10\frac{3}{4}$ lb."

O.U.E.C.3. Lapland.

"Eiderdown quilted sleeping-bags were used throughout the expedition. They were admirable in every way, the patent zipp fasteners being an excellent innovation."
Mason. Shaksgam.

"Two kinds of sleeping-bags were used: single bags for the lower tents and very light double bags made of threefold coating material and two kinds of stuffing for higher altitudes. The double bags weighed only 2·5 kg."

Daszynski. Andes. 84.216.

"With regard to sleeping-bags there is no question that deerskin bags are warmer and lighter, but they require a good deal more attention for purposes of repair than an eiderdown robe, and are more liable to sustain serious damage. An eiderdown robe which has been dropped in water can be dried out, but a deerskin bag may be finished by such treatment, and on the advice of John Rymill, who equipped his expedition similarly in this respect, we carried heavy eiderdown robes. In our case these were made for us by Messrs. Thomas Black, of Greenock. In very cold weather we had an additional lighter sleeping-bag, weighing 2 lb., which could be fitted into the big one, but in practice a single bag was enough. Undoubtedly increased insulation results from the application of this practice of having two light bags instead of one heavy one. We had a heavy drill cover of a special design fitted over the whole of the sleeping-bag, so that it enclosed it when unrolled, and enabled us to roll it up very quickly in the mornings, as well as increasing insulation and preventing snow from getting in, either when on the trail or in a snow iglu. A sealskin, and on top of that a deerskin, provide ample insulation for a sleeping-bag from the cold of the ground or ice."

Shackleton. Ellesmere Land. 87.436.

"Sleeping-bags with wooden slats for protection against wet snow."

Ellsworth. Antarctic. 89.206.

MOSQUITO NETS

Mosquito nets should not be forgotten by mountaineers: essential all along the foothills of the Himalaya, along Greenland coasts, malarial coasts of Arabia, in Persia where rice is grown, etc. A torn net is worse than none as it attracts mosquitoes. Sand flies cannot be kept out by mosquito nets. Net on poles or hoops over camp bed should have fabric top to keep off dew when sleeping out, and broad band of fabric at bottom to tuck in. Nets are often better bought locally. Carry a spare piece of netting for repairs.

In a bungalow an electric table fan beside the bed will keep off mosquitoes, but the draught may give one jaundice and neuritis, and internal chills unless abdomen well covered. In camp the Jost oil-fan is efficient, cheap to run, fairly easy to transport, when comfort is important.

WASHING AND BATHS

Carry washing and toilet gear in an enamel basin with leather top strapped on, *chilumchi* in India; or in lighter aluminium basin with canvas cover. Or take nest of three bowls, outer of metal for washing and two inner of china for eating; packed in cloths they travel well. Alternatively there is an X-pattern canvas washbasin and bath in one. Separate baths of canvas in many patterns. A hole dug in sand with ground-sheet in it makes a good bath.

Sponges get musty in heat, and when damp attract and conceal very small scorpions.

"Washing and toilet things pack in a basin with canvas lid. The Eastern fashion of baths, to stand and pour bowls of water over oneself, enables one to have a complete wash with very little hot water, and a woman can nearly always find a private room in the women's side of the house to wash in."

Freya Stark.

TABLES AND CHAIRS

Some say take none, but most consider a table desirable for meals and essential for drawing, computation, and photography. Avoid table with open slats. Top folding inwards keeps good surface for drawing. Have two tables if possible so that writing not interrupted by laying meals.

The X-pattern chair is out of favour; prefer deck chair for rest and Roorkhee for meals or rest. Latter is good but takes long to set up

and pack; a small deck chair with back shortened to make it pack more easily is hard to beat. Interchange seat and cross bars of Roorkhee chair to make it lower. At least one spare chair is necessary, for receiving a visitor.

TABLE EQUIPMENT

Glass is a luxury only for permanent camps. M.E.E. 1936 used unbreakable Bandalasta ware (Brooks and Adams, Ltd., Barr Street, Hockley, Birmingham). Aluminium mugs, forks, and spoons are light but have a certain taste; duraluminium might be tried. Each man might prefer to carry his own silver plate or stainless steel spoon and knife in a sheath. For sledging only a mug, spoon, and deep plate, with sheath-knife for skinning. Enamelled vessels chip, but for base camp are better than aluminium. Vessels must nest for ease in packing: the Shackleton model had aluminium mug for hash and handled mug for tea fitting together, four pairs packed into cooking pot.

For comfortable travel carry a pantry box and a kitchen box. The pantry box is light, strong ply wood, latticed at all corners, with compartments to carry the following: 2 square containers with lids clipped on for cooked food; square tin or aluminium holders for butter and biscuits, others smaller for sugar, milk, jam, tea, coffee; square teapot and pepper pot, salt cellar and mustard pot; wicker-covered bottle with screw top for lime juice or whiskey; 4 large and 4 smaller plates, 2 dishes, 2 cups and saucers and nest of Beatl tumblers in leather case. In loop in canvas roll carry 4 table knives, 4 small knives, forks to match, 2 table spoons, 4 desert spoons, and 4 tea spoons, corkscrew, Crown top opener and tin opener. Fit a light tray in lid of box.

The kitchen box should contain a nest of 4 aluminium saucepans with detachable handles, a frying-pan with handle detachable or folding inwards, a stout kettle, 2 oblong pudding dishes, a nest of 2 oblong tin bowls for baking bread, a mincing machine, a spare tin with lid for storing fat, a salt cellar and pepper pot. In the lid of the box carry in loops 2 kitchen knives, 2 spoons and a small meat chopper; also a slab of wood about 12×10 inches, and 1 inch thick, for the cook to work upon.

Dry sand from drifts and dunes makes the best cleaning material for plates, mugs, etc.; no dish cloths are necessary. Take care to

clean at once all utensils used for sweetened liquids: once dry the sugar is with difficulty chipped off with a knife.

"One's own plate, glass, etc., is advisable in Persian villages where they are apt to consider that a Christian desecrates their vessels by using them. The nomads, on the other hand, whether Persian or Arab, are pleased if you share their dishes." *Freya Stark.*

COOKING STOVES

Often no stove is required: the cook builds a fireplace in the ground. Chain and hook for hanging a pot are necessary if stones are rare. A petrol tin can be made into an oven, and all flour dishes cooked on an iron sheet or lid of biscuit tin. Packing-cases often supply enough fuel. A 4-gallon petrol tin with its top off and a hole 7 inches square cut in one side makes an efficient fire-pot and cooks quickly. The draught can be adjusted at will merely by turning the hole into or away from the wind. Choose cooking pots so that they fit inside the 4-gallon fire tin and are supported by their handles resting on the edges of the tin. Similarly frying-pans should be big enough to rest on the edges of the tin. Where no local fuel is available, as in a true desert, the supply of 8-gallon wood petrol cases from the normal petrol consumption of car is usually sufficient for all cooking purposes.

Primus stoves are standard, but the roarer type is useless above 18,000 feet. Have uprights detachable to pack into the tin. No. 210 is useful type for sledging. Primus stoves cannot be regulated. Coleman's benzine stove, which can be, was found useful for scientific work on the Great Barrier Reef expedition. At extreme altitudes one may use Meta (solidified spirit fuel) made by Meta, Basel, Switzerland: London agents Elamesen (London), Ltd., 66 Victoria Street, S.W.1. But perhaps in the end Meta weighs more than Primus and paraffin.

The Primus is useful in early morning, but have a fire when possible for cooking dinner, and for men to sleep by. Carry paraffin for stove in petrol tin with screw stopper, and if on the back with a second outer tin to minimize seepage. Methylated spirit or meta for starting.

"In Sinkiang Primus stoves are a nuisance. Meta fuel smells abominably in the heat, and permeates every place and thing. The fuel problem is not so bad as to require these aids. For winter travelling buy a small stove in the country very cheap. This is invaluable set up in the house or inn." *Schomberg.*

"Meta fuel was used as a reserve fuel, and was employed at high camps and bivouacs. It fulfilled all the claims of its makers and was invaluable."
Mason. Shaksgam.

"Juniper, which is the main source of fuel, comes to an end about where the glacier ends. It grows quite plentifully on the terminal moraine. We got juniper scrub carried by means of relays up to 20,500 feet to Camp III, so we did not have to use our spirit fuel except for Camp IV and Camp V. Another reason for not using it earlier was that we found paraffin alone would not burn in a Primus stove. That was what Morshead and Kellas discovered. A mixture of paraffin and petrol would do for a Primus. We had that, and we had Meta, and the result was that when we came down from the day's working out of the route or climbing Kamet, we could get a cup of hot tea as soon as we asked for it." *Holdsworth. Kamet.* 79.12

"The method in common use of making fire is to have two twigs, one fitting into a hole in the other. That with the hole is held to the ground by the feet and the other is quickly revolved between the palms of the hands; a little heap of charcoal soon collects on the piece of dry bark placed beneath, and can be blown into flame soon after it has commenced to smoulder, which is within a minute or two." *Vincent. Port. E. Africa.* 81.323.

In preparation for the Mount Everest Expedition 1936 the R.A.F. establishment at Farnborough, with Mr. Eric Shipton and Messrs. Condrup, Ltd., makers of the Primus stoves, undertook an important investigation of these stoves' performance at low atmospheric pressures in the decompression chamber, exhausted to pressures corresponding to altitudes up to 40,000 feet. The results which follow are referred directly to the equivalent altitudes:

The number 5 Primus burner fitted with the finest stock nipple was entirely unaffected by altitude up to 34,000 feet provided that the tank pressure was 10 lb. per square inch. At 15 lb. per square inch the flame began to "ghost away" from the burner. For altitudes above 34,000 feet special nipples and caps were required, and the burner so fitted worked satisfactorily up to 40,000 feet with a tank pressure of 10 lb. per square inch. On reducing the altitude to 29,000 feet the burner stood 15 lb. pressure without losing individuality of the inner cones.

Roarer burners tested under similar conditions were not found satisfactory. Petrol was tried in a roarer burner and found definitely inferior. The grade of paraffin called vaporizing oil was also tried and was decidedly better than kerosene. Methylated spirit was used to heat up the burners and burned well at 40,000 feet.

The M.E.E. 1936 was equipped with Primus No. 5 and No. 221, fitted with a smaller nipple: both for use on the journey to the mountain, at average altitudes 12,000 to 15,000 feet; for 17,000 feet and

upwards No. 54 stove fitted with special caps, No. 115 Primus range, and No. 2 Hestia oven insulated and modified. With vaporizing oil in place of paraffin these burners would stand pressures up to 20 lb. per square inch to about 22,000 feet, 15 lb. to 27,000 feet, and 10 lb. to 32,000 feet. The only difference between the burners is in the nipple jets which are interchangeable. The heating power deduced from the oil consumption was with these special nipples nearly doubled.

Nipple No. 4390 requires pricker 4605 and nipple No. 4391 uses pricker 4608. The special nipples and caps have no standard reference numbers by which they may be purchased, and any one wishing to purchase should consult Messrs. Condrup, Ltd., 77 Fore Street, London, E.C.2, who will advise on the patterns most suitable.

PARAFFIN

A gallon a week for one stove seems to be the usual ration. This is more than ample for summer work in the Arctic; a quart a week allows for a couple of hot brews per day starting by melting snow. The B.A.A.R.E. gave a gallon a week for a two-man tent for winter sledging, where clothes, mittens, and kamiks must be dried. Glen allowed 1 gallon a week in winter and ½ gallon in summer for two men sledging: Lindsay 1 gallon for three men. Courtauld had 1 gallon a week for his ice-cap station. It should be borne in mind that at high altitudes stoves burn less efficiently and heating becomes protracted, so more fuel may be needed. A minimum found practicable during the M.E. Reconnaissance 1935 was a (50) cigarette tin full per day. It is very difficult to prevent porters from becoming extravagant with paraffin; some system of day-to-day rationing, difficult as it is to put into operation, will often be found necessary where native porters are using Primus stoves.

Another approach to the question of consumption was made by Mr. Augustine Courtauld in a short series of experiments carried out at sea-level in an air temperature of 57° F. It was found that a "roarer" Primus on a rough estimate, *i.e.* without allowing for heat losses by evaporation, convection or radiation, supplied heat to the water in the pot at the rate of 525 B.T.U. per ounce of paraffin. The unit is the amount of heat required to raise 1 lb. of water, *i.e.* 0·8 pints, through 1° F. The warming of the water was checked at about 190° F., so the figure would have been rather higher if the water had been brought to the boil. Under exactly similar conditions a methylated spirit stove (Ideal Express) gave 335 B.T.U. for every ounce

of fuel, while a petrol-burning Primus gave 490 B.T.U. The last conclusion, that a petrol Primus does not give more heat for equivalent weight of fuel, is important.

PRESSURE COOKERS

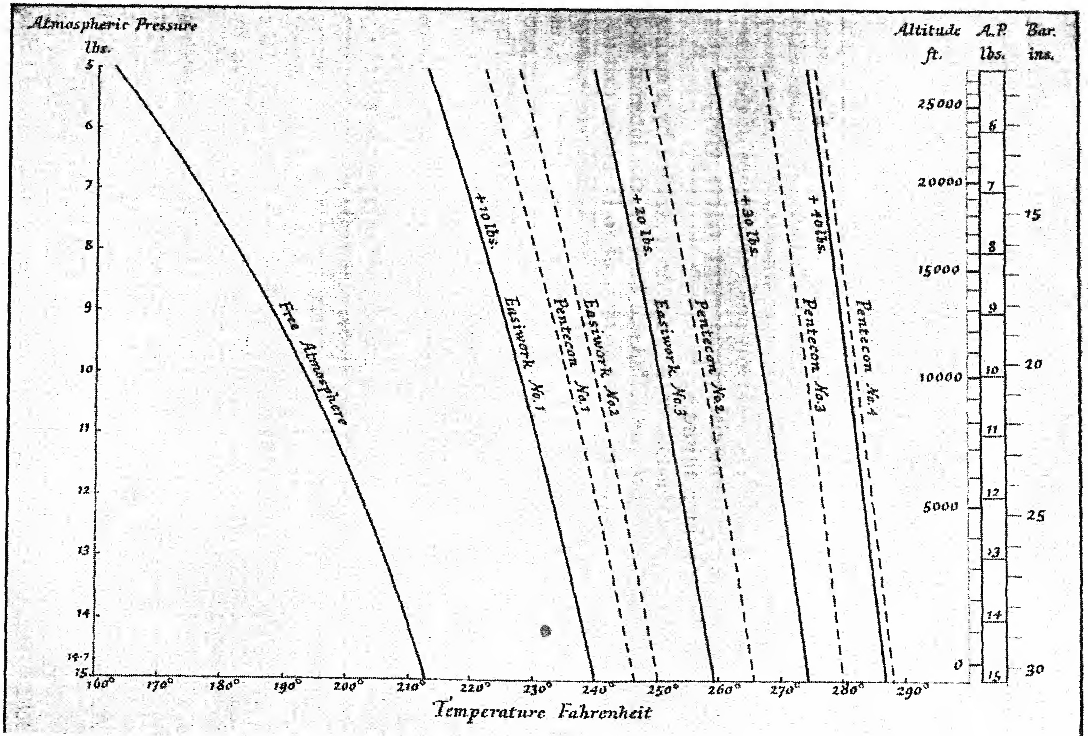
At high altitudes water boils at lower temperatures, which may be inefficient or even insufficient for cooking: hence the importance of pressure cookers when, for example, followers have to be fed upon rice. Also, cooking at pressures higher than the sea-level pressure is more rapid, and greatly economizes fuel: hence their increasing use on shipboard, in stationary camps, or wherever the rather heavy cooker can be carried. The economy and convenience of the latter use has in their commercial development rather obscured the necessity of use at high altitudes.

The pressure as measured by a gauge or controlled by a spring safety valve is of course the difference between the internal and external pressures. A steam gauge pressure of 10 lb. means that the water is boiling at a pressure of $10+14{\cdot}7=24{\cdot}7$ lb. and temperature $239\frac{1}{2}°$ F. if at sea-level, but at $10+11{\cdot}2=21{\cdot}2$ lb. and 231° F. at 7000 feet above sea, and at $10+6{\cdot}7=16{\cdot}7$ lb. and 218° F. at 21,000 feet (Camp III on Mount Everest). Hence the figures supplied by the makers, which apply to sea-level, require drastic corrections at high altitudes.

The diagram gives on the right the relation between Height above sea-level, Barometer (29·92 mean at sea-level), and Pressure in Atmospheres (14·7 lb. per square inch for Barometer 29·92 inches). The heavy curves give on the horizontal scale of temperatures Fahrenheit the boiling-points of water for varying atmospheric pressure and height for each 10 lb. of gauge pressure (relative internal to external). The corresponding curves for settings Nos. 1 to 3 of the Easiwork cooker and Nos. 1 to 4 of the Pentecon are shown by lighter pecked curves.

The Easiwork cooker has a spring valve which can be set by notches to blow a whistle at 10, 15, 20 lb. steam pressure or to be closed right down. It has also a gauge which is calibrated to show internal temperatures 212° to 281°. But before the temperature can reach this the whole lid should lift at a gauge pressure about 30 lb. (274°).

The Pentecon cooker has similarly a whistle valve which can be set to blow at 13, 24, 35, and 41 lb. steam gauge pressure, and a fusible



Atmospheric Pressure lbs.
5
6
7
8
9
10
11
12
13
14
14·7
15
160°
170°
180°
190°
200°
210°
220°
230°
240°
250°
260°
270°
280°
290°
Temperature Fahrenheit
Free Atmosphere
+10 lbs.
Easiwork No. 1
Pentecon No. 1
Easiwork No. 2
+20 lbs.
Easiwork No. 3
Pentecon No. 2
+30 lbs.
Pentecon No. 3
+40 lbs.
Pentecon No. 4
Altitude ft.
25000
20000
15000
10000
5000
0
A.P. lbs.
Bar. ins.
15
20
25
30

safety valve which blows at 60 lb.: but when blown must put the cooker out of action.

The makers supply handbooks with instructions for cooking and statement of the advantages of the method, which must at altitudes be modified by study of the above diagram.

LIGHT

For standing camp the Aladdin lamp with mantle, burning paraffin, gives good light and nearly as much heat as a Primus stove, but will not burn either in a draught or in close air. Used at ice cap station. Mantles too delicate for travelling, when once used.

For general use on march use hurricane lantern (Dietz) burning paraffin, obtainable locally, well understood by servants. Try to get unbreakable glass, or carry in bucket. Electric torches, always desirable, are especially useful in snake country. At high altitudes candle lamps, but are difficult to start in cold at 20,000 feet.

An expedition with cars may use the headlights to light the camp, but it is not satisfactory: too low, and interrupted by people coming or standing in the beam. Better to carry inspection lamps with long flexes and sling them overhead between cars.

Take flints and tinders for use when matches and petrol lighters fail.

The Hellesen dry-battery lamp, costing £1 1*s*. and refills 10*s*. 6*d*., gives a good light, is compact, and lasts well.

"The Italian Alpine Club collapsible lantern is an excellent model, using candles, which can be procured almost anywhere." *Freya Stark*.

WATER TANKS AND SKINS

Tanks should not be larger than 10 gallons, or they are too heavy to move and require siphons, and lose too much if they leak. Two-gallon petrol tins useful with cars, but not on pack animals. Water-skins are light, cheap, and go flat when empty: hold about 3 gallons. Canvas sheets and baths serve on occasion. Canvas water-bottles for cooling, 1 gallon or larger, lose 20 per cent. or more by evaporation, but in dry country the hotter the day the cooler the water. Carry a few strong thermos flasks for comfort and convenience, and a couple of buckets.

The best shape for large tanks is the rectangular flat-sided like a suitcase, with a large filling orifice and a small hole closed with a tap,

cork or bung to draw off water: best made of tinned copper, which stands any amount of banging about, and is better than galvanized iron or aluminium: this last is more delicate, cracks more easily, and is hard to solder. 15-gallon tanks are too heavy when full; 12-gallon are the most practical.

In many ways goatskins have advantages over tanks; they are lighter and pack away easily when not in use; they do not make noises which frighten camels and, owing to the hair which is worn outside and some porosity, they keep water cool. Tank water tends to get nauseating when it is on the hot side, and not very good in quality after it has been shaken up by several hundred miles of marching. Cold skin water, even if not of the purest vintage, is better to drink. But skins require careful treatment; if bought new, they must be broken in with grease, and taste nasty for some time. The goaty taste and smell they give the water is never appetizing, but with good skins it gradually goes. See that the grease used for breaking in is not highly flavoured, *e.g.* rancid; lard or edible oils good for the purpose, but use lard discreetly in Moslem countries, and indeed with a free conscience only when, as often, it is really nothing but solidified cotton-seed oil. Skins full of water must never be laid down on hot soil, sand or rock, or the leather gets scorched and perishes. Skins full of water should be hung up on trees, tripods of sticks, between bales of baggage, etc., or at the worst laid down on matting, canvas, blankets, etc. *Francis Rodd.*

"When in the Nogal at Halin, we used to send 100 miles to Buran to fetch drinking water. Water was transported in 12½-gallon iron tanks, two full tanks being a camel load. We were told that they would not stand up to the battering as well as tanks made of copper, but we found them perfectly satisfactory." *Stafford. Somaliland.* 78.105.

"The container normally used in Egypt, etc., is an oblong steel box with soldered joints, holding 6–12 gallons. It is generally too heavy for the strength of its joints which are very liable to leak. With so large a single container an unnoticed leak will mean a serious loss of water. On this and previous expeditions we have used new 2-gallon petrol tins, replacing the leather washers by rubber ones to prevent the water becoming tainted. We found they lasted fairly well for a one-month's trip of 2000 miles, but after this the vibration starts them leaking along the bottom joints. They were carried in rows of six or seven tins along each running-board, held in place by a wood batten passing through their handles and secured to the running-board below by long bolts. For use, the water was drawn off by syphoning with a piece of rubber tubing in order to save dismantling the tins.

We have also tried soldering up water in ordinary light 4-gallon petrol tins and packing in the 8-gallon wood cases used for petrol. I think this is perhaps the best method of all. The water keeps fresh for long periods and it is quite easy to seal up the filling holes with a piece of tin and a soldering iron."

Bagnold. Libyan Desert. 82.232.

STATIONERY AND BOOKS

Canvas notebooks with good rag paper for records, diary. Small loose-leaf notebook with pencil attached to carry in shirt pocket for use on march. Squared paper useful. Correspondence book with carbon paper for letters and orders. Best quality pencils hardness F or H. Use of ink doubtful, sometimes forbidden, since records in ink, except perhaps draughtsman's waterproof ink, will not stand wetting: nor will indelible pencil.

Duplicate book for record of photographs: one sheet sent with each roll of film for development, and returned with negatives.

Portable typewriter useful on large expedition with plenty of transport, or slow-moving party doing scientific work. Typewriter ribbon dries in hot climate, but carbons not so much. Top sheet may be blank, but carbon copy good.

In wet countries carry books in oiled-silk bag. Contribute to local rest-houses any books you may discard.

Suggest carrying pencils cut in short lengths in a linen roll with pockets, with flange of adhesive tape near top of each pencil to keep it in place. Coloured pencils useful to distinguish notes. Carry surgical adhesive tape for repairing most things.

PROTECTION FROM PESTS

White ants will destroy clothes and blankets in a single night, but not so much gabardine and canvas ground-sheets or bags. Ants will not work in daylight nor touching metal: hence tent poles and furniture must be iron-shod or stand in water or paraffin.

Against snakes the principle is to keep everything off the ground, but they will get into stationary vehicles. Snakes, scorpions, and spiders get into the folds of anything, especially when it is damp, or in cold weather when it is warm.

Oilskin is good protection against bugs and lice. Undress on it or on a sheet of packing paper and keep all clothes off the ground. Leeches, bugs, and ticks can be removed by cigarette ash or salt.

Keep Keating's powder dry in metal container. Carry plenty of such things as Flit, Tell-shox, etc., with sprays, fly-swatters.

"Flit is the only thing I find effective. Take care if possible to change completely for day and night and keep the two sets of clothes at some distance from each other; flit each article separately before putting on and when taking off.

Wear light silk next the skin. Avoid natural-coloured wool, which makes much too good a protective background for lice. A dozen light Japanese silk vests weigh very little, take up scarcely any room, and wash and dry easily.

To prevent ants getting into food, place store boxes, etc., on a table and stand the legs in water. If this is not possible, hang up the food containers and tie a rag damped in kerosene round the string that is attaching them to the branch, or whatever it may be." *Freya Stark.*

"These ants have been known to sweep whole villages clean, including some of their inhabitants, whose eyes they attack first, partially paralysing them with their countless tiny injections of formic acid and eventually picking their skeletons clean. Our army of boys fell out of the house in response to my shouts, and filling their mouths with kerosene, squirted the vanguard before throwing down lighted matches, and then building a low wall of burning grass at a tangent to the house. At first this did not check them, their myriad little bodies piling up and choking the fire to a depth of over 6 inches, but eventually the whole drove veered off to the right and disappeared into the bush. Two hours after dark they were still passing unabated, and I am sure it was some hours before the 'watch,' left to observe their tactics, fell asleep." *Sanderson. Cameroons.* 85.122

"The forest harboured a few pests. The most unpleasant was the *bête rouge*, the tiny larva of a harvest-mite. This almost invisible creature burrows into the softer areas of one's skin, often in considerable numbers. As a consequence of this infestation one's legs get covered with red irritable spots that feel like an attack of nettlerash. It is a troublesome pest in that it gives one sleepless nights, and if the bites happen to get infected they turn into nasty sores. *Bête rouge* has a special capacity for getting into tight and restricted places. Nothing they like better than to squeeze underneath a waist-belt or beneath a bandage round an ulcerated leg. They seemed to be worse on the sunny days that follow occasional showers. Almost every mammal and bird in the forest show signs of being attacked by this pest. Fortunately, a considerable degree of immunity against them develops after one month. Their attacks, though as numerous as ever, produce infinitely less irritation. Kamberol is a good preventative against them, and a saturated solution of common salt a fairly efficient cure.

Ticks were another distinct nuisance. They sit on the forest vegetation waiting for a favourable chance to cling to some creature that happens to pass. Many in this way get on to one's body and fasten themselves to the skin by a spear-like proboscis. In order to deal with these two pests a daily delousing operation was necessary. Each evening it was advisable to go over one's body carefully and pick off the crop of *bête rouge* and ticks that had been collected during the day. The penalty for neglecting this important operation was an itching and scratching night." *Hingston. British Guiana.* 76.8.

"These camps were made extremely unpleasant by the large numbers of tarantula spiders which invaded the circle of light after dark, and it was not uncommon to kill a dozen in one night. Strangely enough, I only saw one scorpion in Danakil, which I put on inside my shorts after a bathe, and got severely stung." *Thesiger.* 85.16.

CHAPTER V. FOOD AND DRINK

To make up deficiencies in local supplies it is necessary to carry European stores, but to live on the latter entirely cuts one off from the life of the people. Plain foods are preferable to luxuries, except on occasion, and in the long run almost any kind of dried food is found preferable to tinned, which may be excellent for a month, and then distasteful.

On the principle that one should live as well as one can for as long as one can, the base should be well stocked with a variety of foods. The difficulty is to provide for long journeys away from the base, with no local supplies whatever, and where every pound weight carried is important, as in sledging, or high climbing. Food must then be concentrated, and planned to give a balanced diet, with the right proportions of proteins, fat, and carbohydrates, and the necessary mineral salts and vitamins. Consider first then the tastes and appetites of the party, and secondly the guidance which recent work on diet may provide, always remembering that individuals vary in their efficiency as machines, some responding much better than others to a diet calculated on laboratory principles.

The importance of scientific planning is greatest in preparing for a long sustained effort in uniform and monotonous conditions. For a few days a man may live on his reserves of muscle and fat, but will then quickly deteriorate unless his food is properly balanced. Hence experience based on a few days is apt to be misleading, and mountaineers have on the whole given less attention to the problems of a concentrated ration for continued use than have polar travellers, and the latter have been more careful to record exactly how they planned their rations. The following discussion is therefore based largely on polar experience, but with the necessary adjustments may guide all who must have a concentrated diet of minimum weight. Remember that winter rations must have more fat than summer; that big men want more food than small, but that it is difficult to make a distinction when all are hungry; that the body gets accustomed in time to the feeling of emptiness a concentrated ration gives at first; that distaste for food at high altitudes tends to disappear with acclimatization, but that lack of oxygen seems to reduce the body's capacity to tolerate unbalanced diet.

BALANCED DIETS

A diet scientifically balanced must contain the right proportion of *Proteins* (from meat, eggs, milk) for muscle and tissue building and repair.

Fats (meat, butter, lard, milk-chocolate) for the gradual production of muscular energy and heat in the body; they have about twice the calorific value of carbohydrates, but are more difficult for the body to assimilate.

Carbohydrates (flour, sugar, etc.) for helping to assimilate proteins and fats, and for producing energy and heat promptly.

Mineral salts (ordinarily from vegetables) and *Vitamins* A, B, C, and D in small quantities, against deficiency diseases such as anaemia and scurvy.

The values of food expressed in figures are usually given in grammes (measured in the laboratory) per ounce (as bought in Great Britain and the British Empire and the United States) for the proteins, fats, and carbohydrates, in this order; and in calories (units of heat obtained by total combustion of the food in the laboratory or calculated from the formula below). But there is no guarantee that the body can consume to full advantage the theoretical value of any individual food, or oxidize it as completely as the bomb-calorimeter does, and waste is inevitable unless the diet is balanced: the first symptoms being lassitude and nausea, especially from excess of fat.

Text-books give the normal ratio of protein : fat : carbohydrate as 1 : 1 : 4. For concentrated diets it is nearer 2 : 3 : 4, giving more calories for less weight by increasing fat and diminishing carbohydrates relatively to both fat and protein. At low altitudes the fat may be still further increased, but probably not at high. In planning consider first the protein. A man at moderate temperatures requires 1 gramme of good quality protein (animal rather than vegetable) per kilogram of his weight per day.

According to the theorists the brain worker and the unemployed require a minimum of 2400 calories per day, with an additional 150 to 300 per hour or more for muscular work. Intellectuals may doubt these figures, since brain work is certainly more tiring than idleness. However that may be, it is agreed that a scientific traveller working hard for a long time should have a ration of value at least 4000 calories. Rations have been devised up to 6000 (Watkins 1930), but later

experience aims at something below 5000, in a daily ration weighing less than 2 lb. per man. Whether this is theoretically enough for hard sledging in low temperatures is not certain: a man at rest in a polar camp requires more calories to keep warm, and one should add to the basic figure 2400, but whether for hard work in cold one should add also to the variable is more doubtful. In any case it does not seem possible at present (1936) to get more than 5000 calories in a balanced 2 lb. ration, and at altitudes above 18,000 feet few can eat more than enough to produce 3000.

VITAMINS

A diet of fresh food usually provides enough vitamins (except perhaps D) and mineral salts: but concentrated rations must be supplemented. The essential Vitamin C (anti-scorbutic) is found in lemons, oranges, grape fruit, green salads, potatoes: destroyed by boiling but preserved in special processes of concentrating lemon and orange juice (lime juice poor in C). Artificial alternative Redoxon (Glen 2 tablets per day 1935).

Vitamins B_1 and B_2 (against beriberi and pellagra) are found naturally in wheat germ, yeast, liver, etc., and in fresh butter (not pasteurized). Supplied by Bemax, yeast, marmite.

Vitamin D (against rickets and bad teeth) found in halibut and cod-liver oil and egg yolk, but not much in other ordinary food. Supplied by the liver oils, Glucose-D, calciferol, and various irradiated products.

Milk chocolates and margarines are often enriched with A, B, and D, and dried vegetables supply B.

"All three were suffering from festering cuts, attributed to lack of fresh food before we started on the trip . . . lived almost entirely on bread and jam and beans. We were short I suppose of vitamin C. However, before the end of the trip we had eaten enough fresh and lightly boiled meat to remedy this defect, and our healing powers improved." *J. M. Scott. Labrador.*

"The first depot-laying party, setting out almost immediately after being landed, took no lemon juice on its sixteen-days' journey. A certain amount of vitamin C shortage was felt, but this disappeared immediately when they started taking the lemon juice on return, although they were still doing the same amount of work." *Glen. Spitsbergen* (1933). 84.129.

COMPRESSED RATIONS

The foundation of the ration is usually pemmican: a Red Indian invention of dried buffalo or caribou meat made into cakes with fat

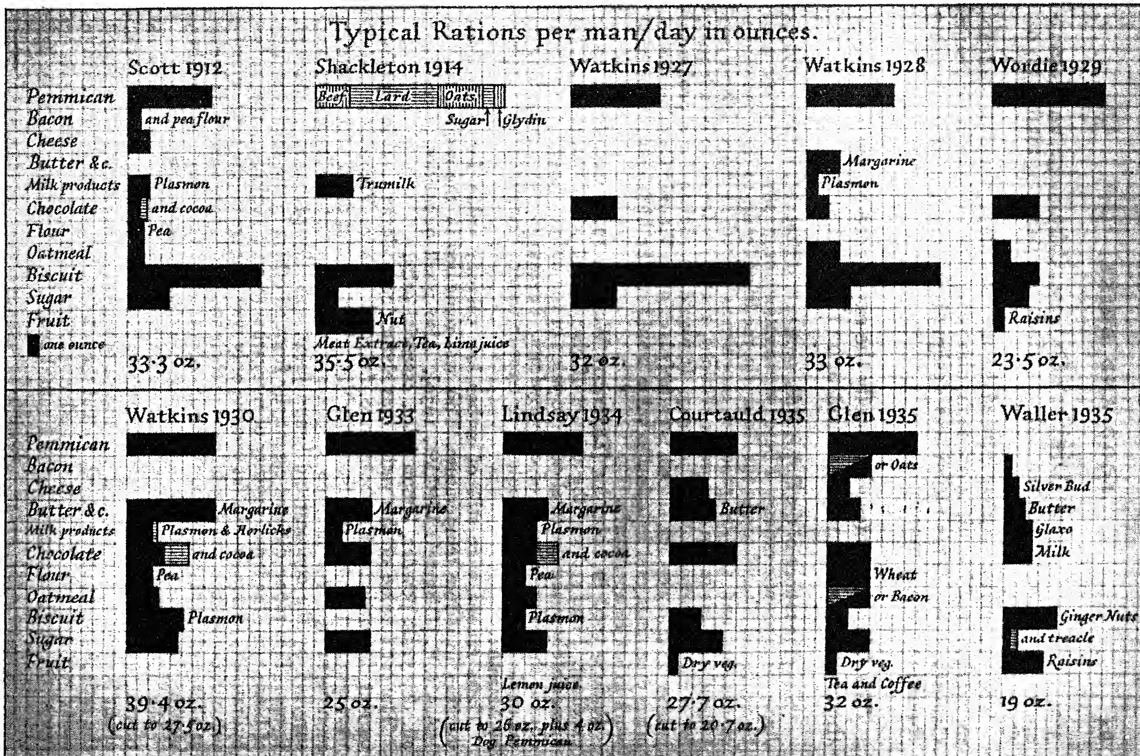
and adopted by Hudson's Bay Company men for their long journeys. It is expensive, but nothing else has so high a content of protein plus fat with high calorie value. Until 1930 the sledging ration was mainly pemmican and biscuit of the naval kind with little fat. For the British Arctic Air Route Expedition of 1930 Watkins cut down the pemmican, introduced a large amount of fat in the form of margarine, and added variety to the ration. Modern sledging rations are based very largely upon his experience.

"One remembered the cynical humour which followed his annoyance with exasperating dogs, and his definition of pemmican, that it kept the body twitching but not the soul." *J. M. S. on Lemon.* 80.559.

Study first in diagram form some typical modern rations. Watkins 1930, and Glen 1935 were designed for expeditions lasting a year, including much winter sledging; Lindsay's for a long summer journey at high altitude sledging with dogs; Courtauld's for a shorter summer expedition man-hauling and climbing. Waller's ration was designed for a quite different purpose, a brief very high climb in the Himalaya.

Recent British practice restricts the name pemmican to its original meaning of dried beef and fat. Shackleton's pemmican, designed for him by Colonel Beveridge, R.A.M.C., was more nearly a complete food. The day's ration of 17 oz. contained 3 of beef powder, 1 of Glydin (84 per cent. protein), 8 of lard, 4 of oatmeal, and 1 of sugar. It was made up in two slightly different kinds, to give a breakfast ration of 8 oz. and a supper ration of 9 oz. with an extra ounce of lard. The firm J. D. Beauvais of Copenhagen make up two mixtures which they call pemmican: the Type Knud Rasmussen, of meat, rice, vegetables, and fat, packed in tins; and the Type Amundsen, of dried meat powder, fat, and vegetables, pressed into cakes and packed in foil. The British pemmican made by Messrs. Bovril Ltd. is of two kinds: man-pemmican containing 45 per cent. protein and 43 per cent. fat, and dog-pemmican with 65 per cent. protein and 28 per cent. fat. All the later rations shown in the diagram are Bovril man-pemmican.

On the British Graham Land Expedition 1934–7 the daily sledging ration was: Bovril pemmican, 5·6 oz.; Blue Band margarine, 5·6; Glaxo full-cream milk powder, 1·6; Rowntree's milk chocolate, 2·4; Rowntree's cocoa powder: no milk, 0·8; Harvest pea-flour, 1·6; Quaker oats, 2·0; Plasmon sledging biscuit, 2·7; Tate and Lyle's cube sugar,



Typical Rations per man/day in ounces.
Scott 1912
Shackleton 1914
Watkins 1927
Watkins 1928
Wordie 1929
Pemmican
Bacon
Cheese
Butter &c.
Milk products
Chocolate
Flour
Oatmeal
Biscuit
Sugar
Fruit
one ounce
and pea flour
Plasmon
and cocoa
Pea
33·3 oz.
Beef
Lard
Oats
Sugar
Glydin
Trumilk
Nut
Meat Extract, Tea, Lime juice
35·5 oz.
32 oz.
Margarine
Plasmon
33 oz.
Raisins
23·5 oz.
Watkins 1930
Glen 1933
Lindsay 1934
Courtauld 1935
Glen 1935
Waller 1935
Margarine
Plasmon & Horlicks
and cocoa
Pea
Plasmon
39·4 oz.
(cut to 27·5 oz.)
Margarine
Plasmon
25 oz.
Margarine
Plasmon
and cocoa
Pea
Plasmon
Lemon juice.
30 oz.
(cut to 26 oz. plus 4 oz. Dog Pemmican)
Butter
Dry veg.
27·7 oz.
(cut to 20·7 oz.)
or Oats
Wheat
or Bacon
Dry veg.
Tea and Coffee
32 oz.
Silver Bud
Butter
Glaxo
Milk
Ginger Nuts
and treacle
Raisins
19 oz.

3·2; Medical dried yeast (Distiller's Co.), 0·4; Califorange, one dessert-spoonful; Adexolin (Glaxo Laboratories), one capsule; total, 25·9 oz. Calories, 4027.

The emergency ration carried in the aeroplane was: pemmican, margarine, and biscuit, 4 oz. each, chocolate 3 oz., Adexolin 1 capsule. Calories, 2595. This ration was designed to keep a man in working condition for one month.

The following notes give briefly the experience on which some of them were based, and judgement upon the results:

"Sledging rations of the B.A.A.R.E. were very different from any previous Arctic or Antarctic rations. I based these rations originally upon those used by Scott and Shackleton in the Antarctic, modified by up-to-date knowledge of dietetics and also by practical experience gained in Edge Island and Labrador. This ration [Diagram: Watkins, 1927] was found to be adequate for a short summer Arctic journey. It would be useless for a prolonged journey in cold weather, since it is entirely lacking in Vitamin C and in several other essentials, and its calorific value would not be high enough for hard work in low temperatures.

Rations used in Labrador [Diagram: Watkins, 1928] were found to be excellent. I had reduced the amount of biscuit, and added margarine. This immediately raised the total calorific value of the rations, since fat has about double the calorific value of carbohydrate. Vitamin C was supplied by fir tea made by boiling the shoots off fir trees in water. Vitamin B was supplied by Marmite.

These rations were still of rather low calorific value for really hard working in a low temperature. This was remedied in the rations for the B.A.A.R.E. [Diagram: Watkins, 1930]. Also small quantities of cod liver oil, dry yeast powder, lemon juice, essential salts.

The total value of this ration was about 6000 calories, and it contained correct proportions of carbohydrate, fat, and protein. Vitamins A and D were supplied by the cod liver oil; Vitamin B by the dried yeast powder, manufactured by Pharmaco Chemical Products, Ltd.; Vitamin C was supplied by the concentrated lemon juice, specially prepared by Messrs. Lyons. This ration differed essentially from all others in the small quantity of biscuit and the large quantity of margarine (8 oz.). Reducing the carbohydrate and increasing the fat was the only way to increase the total calorific value of the rations without increasing their weight. There was no difficulty at all in assimilating this extra quantity of fat. In fact, in very cold weather, working hard, we frequently felt we would welcome more margarine.

We soon found that these rations were more than enough for men travelling between 20 and 30 miles a day at low temperatures at a height of about 8000 feet, and towards the end of our time in Greenland we reduced the rations by about one-third, so that the total amount eaten by one man in a day was 23·6 oz. This was found ample for all normal winter sledging work. On all future expeditions I would keep the rations per man per day

under $1\frac{1}{2}$ lb. I would cut out biscuit altogether, but would slightly increase the chocolate or sugar rations.

On several occasions sledging parties lived for two months on these rations, and all the men used to feel extremely fit at the end of every journey. Courtauld, at the Ice Cap station, lived for five months on these rations on a reduced scale, and was perfectly fit at the end of it, showing no signs indicating lack of anything essential.

On coast journeys where seal meat can be obtained it is unnecessary and foolish to take any ration whatsoever, since seal meat and blubber supply everything that is necessary to life. And after a week or so of living on seal meat most of us lost all desire for civilized foods."

Watkins. B.A.A.R.E. 79.491.

"The scale of 30 oz. per day was cut down proportionately by one-seventh as the ration-box intended for seven days was made to last eight days, to enable the party to stay out longer. This reduced the ration to 26 oz. per day. Parties of the B.A.A.R.E. had managed on less than this, particularly on journeys towards the end of the expedition (when stomachs were accustomed to accommodate themselves to a small bulk, and when the familiarity of sledging rations made no appeal to the appetite), but we, at a time when the temperature was between zero and $-20°$ F. at night, found ourselves ravenously hungry on 26 oz. a day. After a week the ration was increased by about 4 oz. per man per day of dog Pemmican.

When it was decided that the B.A.A.R.E. ration of $36\frac{1}{2}$ oz. would have to be reduced to 30 oz., the margarine was cut down most, as fairly warm conditions were expected. Our temperatures were usually well above zero though $-20°$ F. was experienced at two stages of the journey. 4 oz. of margarine proved quite sufficient except for one member of the expedition, who has an exceptionally bad circulation. 2 oz. of biscuit was quite adequate. 2 oz. of cocoa proved rather more than we could digest. The spoonful of cod-liver oil added to the B.A.A.R.E. ration to increase the Vitamin D content was omitted by us and also the yeast powder and salts and no ill effects were felt.

Were this journey to be done again I should increase the ration to 32 oz. and would not reduce this except in an emergency towards the end of the journey. I would take a ration as follows: Pemmican, 10 oz.; Margarine, 4* oz.; Biscuits, 2* oz.; Oats, $3\frac{1}{2}$ oz.; Plasmon Powder, $2\frac{1}{2}$ oz.; Cocoa, 1 oz.; Chocolate, 3* oz.; Sugar, 4* oz.; Peaflour, 2* oz.; Total, 32 oz. Also lemon-juice and a little tea. The quantities unchanged from our ration of 1934 are marked *. Dr. Zilva states that this ration contains a little over 4500 calories and more than 100 grms. of protein of high biological value; he would be in favour of adding to it 1 oz. of dried vegetables, ascorbic acid tablets and dried yeast."

Lindsay. Greenland. 86.248.

"Owing to the kind interest of such eminent men as Professor Dodds, of the Biochemical Institute, Middlesex Hospital; Professor Drummond, of the University of London; and Dr. Zilva, of the Lister Institute, we were able to discuss very fully the question of the lightest possible ration. To this end some of us submitted to tests for metabolic rate. We wished if possible to get a daily ration invented which would weigh not more than about 1 lb. This we were told was quite impossible, but we knew from experience that

something not much more than this could be used in an emergency. When we decided on taking sledges we arranged a double ration, which would give an ample quantity of high-quality food so long as the sledges could be kept going, and could then be cut down by one-third to 18 oz. when we were forced to carry our loads. [Ration shown in diagram, p. 63.]

In addition vitamin C tablets (Redoxon: Roche Laboratories, 51 Bowes Road, London, N.13) were taken every two or three days, and each pair of men was supplied with luxuries to the extent of 2 lb. of oats and 1 lb. of sweets, which were to be consumed as desired and abandoned when necessary. Everything in the reduced ration could be eaten uncooked if weight of stoves, fuel, and cooking gear had to be saved." *Courtauld. E. Greenland.* 88.207.

Mr. Glen on his return from Northeast Land suggested his ration would have been bettered thus: of 4 oz. oats take 2 for porridge and 2 for mixing with wheat flour to make cakes or scones, more filling and economical of fuel than porridge. Cut down sugar to 2 oz. and add 2 oz. golden syrup. For coastal sledging in spring and summer little but flour and coffee required to supplement seal.

"The food was principally pemmican, sunwheat biscuits, bouillon cubes, bacon, butter, milk powder, dried fruit and tea, and the full daily ration for 61 days was 34 oz. computed to contain 15 per cent. protein, 28 per cent. fat, 56 per cent. carbohydrates, giving 4860 calories.

The pemmican was of two brands—the Amundsen type made by the Beauvais Co. of Copenhagen, and another made to the formula of Mr. D. C. Coman, of Johns Hopkins University. The latter had some pepper in it and for my part I preferred it. I always find that one or two fixed rations are better than a great variety. On this flight we had for breakfast a mug of oat porridge with cubes of bacon; dried milk and sugar, and oat wafers with butter. For supper, a mug of pemmican with biscuits and butter. I never tired of this and always looked forward to it. We must have used much less than the 34 oz. per day of our schedule." *Ellsworth. Antarctic.* 89.207.

The diagrams give a preliminary view of the subject; the rations they suggest must now be examined arithmetically, and their constituents in terms of protein, fat, and carbohydrates added up to see how they balance. The table on pp. 68 and 69 may give approximate figures; but it is necessary to obtain the analyses of the foods selected, and to have guarantees that the articles supplied conform.

One should not rely too much upon these numbers. The process of analysis is something like this: The water is determined by drying. The total nitrogen is then determined, and 6·25 times this total is taken to be the Protein content, usually without distinction between vegetable and animal protein. The matter extracted by ether is taken to be Fat, but may contain resins and other things. The ash remaining after heating below redness is the Mineral content, though sulphur and other things may have been burnt off. The Fibre, deter-

mined in some analyses, is indigestible "roughage." The difference between all these and the total weight is often taken as the "nitrogen-free extract" largely starch, sugar, and organic acid, roughly termed Carbohydrates. Analyses of the same food at different times vary, owing partly to errors in analysis and partly to variations in composition. Usually the analyses are given to three or four figures, but not more than two are significant.

The calorie values are sometimes determined with the calorimeter, but more often calculated from the formula Calories $=4{\cdot}1$ (Protein plus Carbohydrate) $+9{\cdot}3$ fat. Not more than two figures in the results can be significant, and these two are useful indications of the ration value but not to be taken too seriously.

As an example of calculating the calorie value of a ration take Courtauld's of 1935:

		Prot.	*Fat*	*Carb.*	*Cal.*
Pemmican	6·0 oz.	76 g.	73 g.	— g.	978
Cheese	3·3	27	29	—	409
Butter	4	—	97	—	920
Choc. Bemax ..	6	17	68	74	1008
Biscuit H.P. Exp. ..	2·8	7	3	59	302
Sugar	4·8	—	—	136	557
	27·7	127	270	269	4174

$$(127+269)\times 4{\cdot}1+270\times 9{\cdot}3=4135$$

Ratio Prot. : Fat : Carb. is 1 : 2·1 : 2·1

The figures in the last column are calculated from the calories per ounce as given in the table. As a check we calculate from the total protein, fat, and carbohydrates in the ration, by the formula above, and find the same result to two significant figures, which is all we can expect. Other rations give:

Watkins	1930	39·4 oz.	6000 cal.	1 : 1·4 : 1·5
Lindsay	1934	30	4300	1 : 1·0 : 1·3
Glen	1935–6	32	4400	1 : 1·4 : 2·1
Waller	1935	17·9	2400	1 : 2·9 : 6·5
Rymill	1934–7	25·9	4000	1 : 2·0 : 2·2

For the analyses of the named products we are indebted principally to the chief chemists of the manufacturing firms, who have responded most kindly to troublesome requests, sometimes having special analyses made. The sums of the numbers in the first five columns are given in the sixth. When the sum is exactly 28·35, the number

of grammes in the ounce, one may assume that the numbers have been adjusted, or that one has been obtained by difference from the total. When the sum is markedly below 28·35 the deficiency may be taken as the equivalent of the complex constituents, fibre, etc., outside the scope of the analysis. Note that the proportions of the three principal constituents vary greatly in different brands of chocolate, milk foods, and biscuits.

Man/day rations save much trouble but should be of alternative kinds whenever possible, to save monotony, or supplemented by extras from a monthly luxury box. They keep the standard of fare uniform, but lead to waste if the ration is ample, unlikely in small sledging parties.

The diagram shows that the standard rations were much cut down when necessary, by making a seven-day box last say for ten days. Here variety is important. When a sledging party is held up by bad

COMPOSITION OF FOOD

Constituents in grammes per ounce: 1 oz.=28·35 grammes.

	Prot.	*Fat*	*Carb.*	*Min.*	*Water*	*Total*	*Cal.*	*Auth.*
Pemmican								
Shackleton Brft.	7·50	13·38	6·00	0·60	0·79	28·27	180	Bev.
Bovril (Man) ..	12·66	12·16	*nil*	1·86	1·26	27·94	163	Makers
Beauvais								
K. Rasmussen	7·25	12·84	3·35	0·28	4·63	28·35	162	B.A.C.
Amundsen ..	7·00	12·53	7·14	0·56	1·12	28·35	174	B.A.C.
Bovril new Army								
iron ration ..	7·80	8·22	9·81	1·06	1·42	28·31	147	Makers
Bacon (raw) ..	2·3	18·5	*nil*	1·2	6·3	28·3	182	H. & M.
Cheese								
Cheshire.. ..	8·3	8·7	*nil*	1·2	9·4	27·6	124	H. & M
Silver Bud ..	6·50	9·25	*nil*	1·28	11·20	28·23	113	Makers
Butter	—	24·2	—	—	3·5	27·7	230	H. & M.
Margarine (Van den Bergh)	0·06	23·67	*nil*	0·42	3·97	28·12	224	Makers
Milk foods								
Glaxo Full Cream	7·06	7·51	10·91	2·04	0·82	28·34	144	Makers
Horlick's Malted	4·11	2·30	20·13	1·02	0·79	28·35	121	Makers
Plasmon	23·04	0·03	*nil*	2·28	3·00	28·35	95	Makers
Chocolate								
Bemax	2·9	11·3	12·4	0·43	0·37	27·4	168	Makers
Cadbury's Bournville (plain)	1·2	9·2	17·0	0·34	—	27·7	159	Makers
Fruit and Nut	1·4	7·6	17·1	0·47	—	26·6	145	,,

	Prot.	Fat	Carb.	Min.	Water	Total	Cal.	Auth.
Chocolate								
Cadbury's Milk ..	2·3	9·9	15·0	0·56	—	27·8	163	Makers
Milk, fruit, nut	2·2	8·1	15·8	0·62	—	26·7	148	,,
Caley's Marching	1·7	9·6	16·2	0·35	0·50	28·3	162	Makers
Fry's Belgrave (pl.)	1·1	9·5	16·9	0·28	0·26	28·0	162	Makers
Milk	2·6	9·8	15·2	0·45	0·26	28·3	162	,,
Rowntree's Plain	1·6	9·4	15·7	0·37	0·14	27·2	158	Makers
Milk	2·5	10·0	14·7	0·57	0·17	27·9	165	,,
Cocoa								
Cadbury's Bournv.	5·1	7·5	10·2	2·2	—	25·0	138	Makers
Bourn-vita	3·7	2·3	20·5	0·85	—	27·4	120	,,
Cup chocolate	1·5	5·5	20·1	0·40	—	27·5	139	,,
Cocoa and milk	3·4	1·6	21·6	0·9	—	27·5	118	,,
Fry's Breakfast ..	4·9	7·4	10·7	2·02	1·36	26·4	137	Makers
Malt milk, eggs	4·4	2·7	18·7	1·11	0·99	27·9	118	,,
Rowntree's ..	6·3	6·7	6·8	2·0	1·4	23·2	116	Makers
Flour, Wheaten ..	3·8	0·4	20·6	0·2	3·4	28·4	104	H. & M.
Pea	7·9	0·6	16·1	0·7	2·9	28·2	104	H. & M.
Oatmeal	4·0	2·1	18·7	0·5	2·0	27·3	113	H. & M.
Plasmon Oats ..	5·46	2·47	17·92	0·57	1·93	28·35	119	Makers
Quaker Oats ..	4·17	1·76	19·79	0·43	2·21	28·36	115	H. & M.
Bemax (cereal embryo)	9·63	2·41	13·18	1·28	1·42	27·92	112	Makers
Biscuit								
Huntley and Palmer's								
Antarctic ..	5·95	0·71	17·01	0·74	2·21	26·62	101	Makers
Expedition ..	2·66	1·13	21·15	0·71	1·73	27·38	108	,,
W. and R. Jacob's								
Plasmon plain	5·24	5·81	15·31	0·71	1·27	28·34	138	Makers
Wholemeal ..	3·69	5·39	17·29	0·71	1·27	28·35	136	,,
Macfarlane Lang's								
Ginger nuts ..	1·38	3·00	22·37	0·29	1·10	28·14	125	Makers
Granola ..	2·02	6·21	18·46	0·52	0·92	28·13	142	,,
Toasted wheat	2·50	5·77	17·85	0·63	1·20	27·96	136	,,
McVitie and Price								
McVita ..	2·4	6·5	15·7	0·7	0·8	26·1	134	Makers
Peak Frean								
Shortcake ..	2·27	7·48	17·69	—	—	27·44	152	H. & M.
Ryvita	3·29	0·37	21·20	0·51	2·25	27·92	104	Makers
Sugar, lump or barley	*nil*	*nil*	28·35	*nil*	*nil*	28·35	116	
Glucose-D ..	trace	0·14	28·1	0·14	trace	28·29	128	Makers
Golden syrup ..	*nil*	*nil*	23·0	0·4	4·6	28·0	89	H. & M.

Authorities for the above figures are indicated in the last column. Makers usually means that information was given by the Chief Chemist; H. and M. that figures are from Hutchison and Mottram (*Food and the principles of Dietetics:* 8th Ed. 1936); Bev. refers to Colonel Beveridge, R.A.M.C., who designed the ration; B.A.C. is British Analytical Control.

weather there is time for experiment in cooking, when flour is essential, and even ices made from snow have been found acceptable.

Figures such as those above are necessary in planning compressed rations, but they should be borne in mind in all victualling, so that there be no deficiency. Tastes and transport and local supplies vary so much that it is difficult to generalize.

CHOICE OF EUROPEAN STORES

For life at a polar base take plenty of flour and baking powder for making bread; oatmeal and rice; potatoes and oranges protected from frost; tinned vegetables, dried fruits, and sweet things for occasional feasts; tea, coffee, and cocoa to taste; milk chocolate as part of a meal, plain as a luxury, Bemax for its yeast content. Dried vegetables, Julienne or the Italian *Arrigoni* for soups contain essential salts and vitamins. Margarine keeps well and butter is more palatable but keeps less well; tinned butter has often lost its vitamins in preparation; Danes in Greenland use lard flavoured with onions and prunes. Live as long as possible on seal, fish, and eggs, saving compressed rations as pemmican for long inland journeys. Carry lump sugar or Glucose-D, and dried fruit in pocket for stimulus when very tired; effect is rapid. Concentrated lemon juice with its vitamin C makes refreshing hot drink at end of march.

"*A sledging menu:* for breakfast porridge and lump sugar; or bacon, said to give more energy but less filling: makes less steam in cooking. For supper pemmican made into *hoosh* (a word said to be from the same Gaelic root as whisky) with oatmeal and dried vegetables; this simple hoosh needs less stirring and makes less steam; plasmon and peaflour apt to burn if not stirred continuously. Few can eat more than 4 oz. of pemmican as plain soup, but 8 oz. a day even in summer if cooked with oatmeal; tastes as good after four months as at the start, but cannot stand raw or plain boiled pemmican. Usually saved most of the biscuit and margarine for supper, but sugar and chocolate mostly went during the day's sledging, spread out to break the monotony, or eaten during brief rests after difficult work. For a day in camp make lunch a smaller supper." *J. W. Wright.*

"The food rations were based upon those used by Watkins during the British Arctic Air Route Expedition, but were modified for the different conditions. It appears to be worth noting that we lived for seven weeks on 26 oz. a day, viz. 6 oz. of biscuit, 8 oz. Bovril pemmican, 4 oz. 'Anchor' butter, 4 oz. Cadbury's chocolate, 4 oz. sugar. Besides this we had Bournville cocoa to drink twice a day, and Horlick's Malted Milk Tablets on special occasions. We found that this ration contained sufficient nutriment, but did not entirely satisfy the desire for food, and it would have been prefer-

able had we substituted something more permanent for a small part of the pemmican ration." *Roberts. Iceland.* 81.291.

"Variety can be introduced by taking brown, white, and barley sugar, and different kinds of oats as well as of chocolate. Some toffee ought also to be taken.

The food used by the Base party was the ordinary English diet. In Klaas Billen Bay fresh meat can always be obtained at the Nordenskiöld Glacier face, where seals and bird life are plentiful. For boat journeys bacon is excellent and a good amount ought to be taken. Plain corned beef was found to be more popular than such foods as tinned pies, etc., but a larger proportion of carbohydrates is required if non-active work, such as that of Bruce City, is being done. Fresh bread was only made after the return of the northern parties, and was much appreciated. A full-time cook ought to be taken on an expedition with a large personnel." *Glen. Spitsbergen* (1933). 84.129.

"Occasionally fresh mutton was obtained (*e.g.* at Mieron). The stores actually carried included oatmeal, bread, or *biscuit*, together with a kind of 'ry-vita,' a little flour for thickening dishes, rice, *tinned meat*, *Bovril*, *pemmican*, dried fish, dried mutton or reindeer meat, cheese, *raisin-chocolate*, *dried fruit* (including apple rings, apricots, raisins, figs), sugar, tea, coffee, and dried or condensed milk, and dried *chocolate-milk powder*. Many of these were in small amounts only, as a variant on the ordinary diet, which included a great deal of porridge. The foods marked in italics should be brought from England, either because they are better there, or cannot be got in northern Norway." *O.U.E.C.3. Lapland.*

For mountaineering, study the narratives of recent high climbing expeditions for much information on diversity of tastes; loss of and stimulus to appetite at high altitudes; preservation of appetite by acclimatization; special high altitude rations. Take plenty of condiments to make inferior meat appetizing; jam in good variety; plenty of sugar, rice, lentils, dried vegetables and milk. Consider also the experience of polar travellers.

Lieut. Waller's high-altitude ration of 19 oz. shown in the diagram was designed for a short period of high climbing: remarkable for having no meat except a little bacon; one might do without much protein and on less than 3000 calories for ten days. Four Europeans and six Sherpa porters kept fit on it for eighteen days up to 24,500 feet on K36; they did not lose weight, and were free from mountain diarrhoea. For the porters part of the biscuit ration was replaced by tsampa; no religious objection or complaint. The standard Glaxo (full cream milk powder) made hot drink and was eaten raw. The Europeans got thoroughly tired of ginger nuts and treacle and wanted more area to spread butter on; and they felt the lack of bulk. Another time they would take some plain biscuit, barley sugar instead of treacle,

and probably shortbread instead of ginger nuts. The ration seems worth further trial for parties doing most of their porterage themselves.

"Experience has shown that parties going to high altitudes suffer from considerable loss of appetite, and have, in fact, to make a duty of eating. It was therefore necessary to devise a high-altitude ration which should include the correct quantity of vitamins and calories. Doctor Zilva of the Lister Institute very kindly came to our help in the matter. In the event, our calculations were somewhat upset by the fact that slow acclimatization enabled the climbers to assimilate the ordinary foods of civilization up to and even beyond a height of 23,000 feet; and we were obliged to draw upon stores intended for the march and for the lower camps. To eliminate the risk of scurvy in a country like Tibet, where fresh vegetables, fruit, and fresh meat are difficult to obtain, we had recourse to a highly concentrated form of lemon juice.

One result of slow acclimatization is the continued capacity to eat more or less normal food at considerable altitudes. A special high-altitude ration is hardly necessary for acclimatized men up to Camp V."

Ruttledge. M.E.E. 1933. 83.2, 9.

"Supplies, mainly tinned, for the British officers, were bought from the Army and Navy Co-operative Society, London; they were packed in three-ply wooden boxes, each weighing 56 lb. when full. Variation of diet was considered in the selection of food. There were three types of boxes:

A. Six boxes arranged for the journey from Srīnagar to Pānāmik and back, each approximately to last four officers for a fortnight. These allowed for local purchase of meat, eggs, vegetables, flour and milk.

B. Twenty-four boxes each arranged to last four officers for five days, for the period of the exploration beyond Pānāmik. With a small addition from reserve, they were made suitable for two officers for ten days. They allowed for no local purchase but were supplemented in Kashmīr by additional supplies of flour, sugar, and butter.

C. Four boxes of sauces, occasional luxuries, etc.

There were also four boxes in reserve, and one box containing 20 lb. of tobacco." *Mason. Shaksgam.*

For desert travel by camel European stores are cut down to the minimum: for travel by car they may be much more elaborate.

The basic European stores required in less strenuous travel to supplement local food do not differ very much. Following are brief lists furnished by experienced travellers:

For East Africa: tea, coffee, sugar, condensed milk, biscuits, sago, cornflower or tapioca, dried fruits, sauce, chutney, curry powder, tinned sausage, tongue, sardines, potted meat, and lard or dripping for cooking.

For tropical islands: tea or coffee, sugar, tinned butter and lard, flour, tinned meats, salt, and delicacies for use when continued bad

weather makes life almost unbearable. Chocolates do not stand the climate well. Travel light on tinned meats, rice, and plenty of jam, tea, and sugar.

For China: tea (unless one drinks Chinese green tea), coffee, cocoa, sugar, tinned milk and butter (the Chinese do not generally produce either milk or butter), jam, cooking fat, baking powder, table salt, soup sticks or squares.

The question of food supplies is very simple in S.E. Tibet, for one can live on the country very easily, and even luxuriously with the aid of sauces and tins of jam. Take a few tins of herrings, sardines, bully beef, Christmas puddings, etc., for celebrations and occasional variety; and at least for the first year of the expedition a weekly ration of plain chocolate is a very great treat; but no great thought need be wasted on stores. Meat, butter, milk, tsampa (a flour made from roast barley) and salt can be bought nearly everywhere, and frequently wheat-flour, rice, brick-tea, sugar, and chillies. Butter is eaten and drunk in such quantities that it forms a most efficient substitute for fresh vegetables, and scurvy is unknown. *R. Kaulback.*

"Owing to our limited transport it was essential that the weight and bulk of our food supplies should be kept as low as possible. The scale per man per day was carefully worked out and is tabulated below:

Meat, 9 oz., or 4½ oz.+2 eggs.	Milk, 1½ oz.
Fruit, 4 oz.	Margarine, 1 oz.
Vegetables, 3 oz.	Tea, ¼ oz.
Potatoes, 2 oz.	Lime juice, 1/16 bottle.
Onions, 1 oz.	Whisky, 1/16 bottle.
Army biscuits, 4½ oz.	Sugar, 2 oz.
Fancy biscuits, 1 oz.	Marmalade, 2 oz.
Chocolate, 1 oz.	Flour, 2 oz.
Cheese, 1¼ oz.	Lard.

This scale could not reasonably have been reduced any lower.

The longest period to be catered for was that of forty-two days between Cairo and El Fasher, during which we could not rely on obtaining anything from the country *en route*. The reserve allowance for this period was an additional seven days' food. We had four meals on a normal day: Breakfast at 6.30 consisted of eggs or tinned fish or sausage. At 11 a.m. we halted for chocolate and biscuits. Lunch, cold, consisting of tinned fruit, cheese, jam, and biscuits, was usually at 1.30. Dinner at about 7 p.m. contained meat and vegetable, usually as a stew. The food required on a long motor expedition of this sort is very different from the simple fare to which the camel. traveller is accustomed. Owing to the violent physical exercise continually demanded in extracting cars from soft sand by digging and pushing, and in man-handling stores, etc., and to the mental exertion of driving a car all day over a continuous hazard or of high-speed navigation, a full and varied diet

is very necessary. Although we had to be content with little but tinned food, the quality and variety which is available nowadays is remarkable.

Our diet was naturally influenced by the weather, which at the beginning of the journey was hot. It remained so throughout the outward journey to El Fasher and until November 8 on the return, after which it was definitely cool. During the cool period there was a noticeable demand for more of everything, and meat was wanted in the middle of the day instead of tinned fruit.

The normal water ration during the early hot period was 5 pints. This was consumed as follows: 1 pint as tea for breakfast, 1 pint with lime juice for lunch, and 1 pint in waterbottles to be drunk as individuals liked. The remaining 2 pints were drunk after arrival in camp, one as tea and one with whisky." *V. F. Craig. Libyan Desert.* 82.233.

"For food I depended primarily upon camel's milk, though I took a limited supply of cocoa, meat extract, biscuits, butter, and malted milk tablets as transport conditions allowed. Ordinarily the Badus of the sands live exclusively on camel's milk with an occasional meal of camel's meat. But the cow in milk is not ideal for long forced marches across the desert, wherefore I carried hard rations for my party, and only two camels in any of my camel relays were in milk: these for myself. . . . I started off each morning with a flask of camel's milk, and this was the only sustenance I had throughout the long day. Hunger and thirst were tormenting for the first few days, but not afterwards. I kept fit throughout my two months' journey, but lost a stone and a half in weight.

I did not drink water myself except when extremely thirsty, as I depended on camel's milk for the most part for my diet, but even camel's milk is brackish when the camel is grazing on saline pastures."

Thomas. Rub' al Khali. 78.216, 7, 9.

"I had allowed myself one camel to carry my boxes of instruments, clothes, food, and bedding. Thus, out of a total load of 250 lb. I could allow 80 lb. for food, and 20 lb. for bedding and clothing. I did not, of course, take a bed, table, or chair, and I decided to dispense altogether with cooking. My staple diet was to be dates, biscuit, and cod-liver oil. I added to these essentials 1 lb. of chocolate, 10 lb. of raisins, two ½-lb. tins of grapefruit, and a tin containing nearly 10 lb. of wholemeal flour."

Orde Wingate. Libyan Desert. 83.286.

"The ordeal of the fast is not really as terrible as it may sound except to those who eat and drink excessively during the night. After about twenty days of it one begins to feel a little weary at the sense of restraint, but then one can begin to count the days remaining and to hope that there will be only twenty-nine instead of thirty, while when that hope is disappointed there is but one day to go. Hunger one simply does not feel during the day after a very unappetizing meal of plain rice cooked in butter taken at about 4 a.m., while thirst can easily be subdued by a restrained use of liquid during the night hours. In my case I avoided water altogether and continued the practice far beyond Ramdhan, with the final result that I did fifty-five days without a cold drink of any kind, my substitute being tea and freshly drawn camel milk (warm and frothing). During this period I never experienced thirst, and I would have continued it to the end had not my supply of tea

run so short that I had to use the same tea-leaves over and over again for three or more brews, while naturally enough the supply of camel milk became less and less plentiful and I had eventually to give up my private cow to the community. During Ramdhan I contented myself with two small pots of tea, one at sunset each day and the other after the pre-dawn meal, and a bowl of milk, while some of my companions made their fasting hours a real penance by drinking long draughts of water at sunset and during the night."

Philby. Rub' al Khali. 81.4.

". . . we had to march for 8 or 9 hours a day between the Dadessa bridge and Mendi in order to complete the journey in the allotted fifteen days. During this time we subsisted on a diet of rice, dates, marmite, tea, and sugar."

Dunlop. W. Ethiopia. 89.517.

COOKING

The *argols* (dried cattle or yak dung) of Tibet and Mongolia burn well in expert hands. Dry tamarisk and desert poplar make good fuel in deserts of Mongolia and Turkistan. Brushwood of the Pamirs, burned in an open fire under the hole in the roof of a Kirghiz tent is the worst fuel of the lot; sit on the ground and the smoke will not be so bad. When using juniper and other smoky fuels, cook with the lid on.

In typhoid country eat everything hot from the stove: anything cool has had flies on it. Infected washing-up water and damp plates are as dangerous as unboiled drinking water. Even restaurant cars in hot countries may be better avoided.

Chinese do not bake bread, but something can be done by toasting slices of steamed bread.

In great cold keep the cooking pot covered or the steam condenses as hoar frost in the tent; this is against using flour, oats, plasmon powder, and dried vegetables, which make the hoosh more appetizing but want continual stirring. If they are placed in the pot nearly full of melting snow or ice they congeal less, though all tend to form lumps, stick to the pot, and burn. When the snow is melted and the oats, etc. swollen, add the pemmican cut into very small pieces; it thus mixes better and does not stay at the bottom of the pot for the cook's benefit. Boil for at least one minute, take off the stove and allow it to thicken, boil for another half minute, and serve. Of dried vegetables spinach goes best with pemmican. Flour gives variety, and is especially valuable when stormbound; with flour, butter, and a little cheese one makes pemmican rissoles, and many other things when seals or birds are shot.

J. W. Wright.

"The Turki cooks his food with linseed oil, and few Western or even Indian stomachs can tolerate it." *Schomberg.*

"The native hole and stone oven is used to cook most foods. An astonishing variety of dishes can be made from yam, mixed with other stuffs to spice such as palm-shoots, beetle larvae, whole eels (which swarm in the tiniest patches of moisture about December), prawns, turtle and megapode's eggs, sedge shoots, pig, fruit-bat (*Pteropus geddei* and *P. eodinus*), rose-apples, *nungi* nuts, coconut oil, 'native cabbage' (the red-veined leaves of a small bush), red earth, pigeons, doves, parrot, fowl, various wild fruits in their season, unripe banana (not popular here, though a staple on the Atchin group of islets and in some Small Nambas)." *Harrisson. Malekula.* 88.115.

PACKING

Aim at having the principal rations put up in rectangular tins with soldered strip easily opened, or in cartons, of size to pack exactly into standard ration boxes designed to fit the sledge or to make a full load. Number the boxes on several faces and paint with coloured stripes placed so as not to be hidden by lashings. Boxes usually of three-ply wood nailed and strapped or wired, with contents to make alternative rations for so many man/days according to standard load. When a box is opened move whole contents into a padlocked container such as a yakdan.

Detached parties travelling light save weight by carrying stores in sacks and canvas or coarse brown holland bags tied with tape; but fat foods must generally be left in tins.

LOCAL SUPPLIES

Every well-planned modern expedition makes as much use as possible of fresh native food, and studies to supplement supplies of tinned meat by hunting and fishing. In the Arctic it is possible to live well on seal and nothing else, but living on the country by hunting takes a large proportion of the time otherwise available for travelling and scientific work. Of seal the liver may be eaten raw, but generally fried; boil the rest slowly, or slice across the grain of the meat and fry with butter, salt and pepper. Avoid the liver of hungry animals, and of bears, perhaps because they are usually hungry. Seagulls and guillemots must be skinned, and are best boiled. The latter's eggs are fried, scrambled, or made into omelette.

"In winter the Eskimos hunt seals in various ways, but the most common method at Angmagssalik is to stand along the edge of the open water and shoot them when they swim along near the ice. Practically no skill is required in this method other than straight shooting, and the Eskimo who gets most seals is the man who goes out most often or who has the best rifle. Later in the year various methods of harpoon-hunting are used. This requires more

skill, but the spring hunting is the most difficult, although this does not compare in difficulty with the summer kayak hunting. In spring the seals come out of their breathing holes on to the ice and bask in the sun. While a seal is basking in the sun it will usually sleep for about thirty seconds, then wake up and look about for five seconds, and then sleep again for thirty seconds.

It is possible to use two methods for hunting a seal on the ice. In the first method dark clothes are worn and the hunter wriggles up to the seal while pretending to be a seal himself. This is a very slow method, taking sometimes two or three hours to approach a seal. In the second method, which is quicker, the man creeps up to the seal behind a white screen. He only moves while the seal is sleeping, and if the seal gets disturbed he has to remain in one place until it is quiet again. A good hunter can always get to within 25 yards of a seal. He then shoots it in the head and immediately runs towards it to catch it, since the impact of the bullet will often set it sliding down the inclined plane of ice into its hole and it will be lost under the ice." *Watkins. B.A.A.R.E.* 79.363.

"In the time past the Eskimos used to hunt with the harpoon from their kayaks; seals were plentiful and it was not very difficult. Unfortunately, owing to the large numbers of seals killed every year by the European sealing ships, they are now becoming scarce and the Eskimos are using other methods. Some use a large-bore rifle. This of course kills the seal, and it sinks; it is however sometimes possible to get near enough to harpoon it just as it is sinking. Other Eskimos use a light rifle; this does not always kill the seal, but wounds it. Then it can be harpooned when it is struggling about. Other Eskimos use a shotgun and try to blind the seal and then harpoon it. Owing to the fact that they have not any standard method of hunting a seal, they lose about four out of every five seals which they hunt.

I spent the first fortnight of the [boat] journey in shooting ducks, guillemots, and gulls from my kayak in order to keep us supplied with food. But I also spent a great deal of the time in watching the summer habits of seals. I knew a good deal about their habits before, but before I could hope to get seals regularly in my kayak I must be able to tell at 100 yards the type of seal, whether it was young or old, and what it was doing, whether playing or travelling, or resting. Each requires a different method of hunting. I soon came to realize that the shotgun and harpoon method was the only sure way to get a seal from a kayak.

The actual hunting of the seal is a long and complicated matter, and unless you are a very experienced hunter you will probably only get near enough to have a shot at one out of every six seals that you see. After a seal has been shot with the shotgun it will dive and, depending on what type of seal it is and how old, it will remain down for anything between five minutes and twenty minutes. With experience one knows almost exactly when it will come up, and before it dives again you have to try and harpoon it. The head of the harpoon sticks in the blubber of the seal, and then it starts struggling to try and get away, and will even try to attack the kayak. The Bladdernose seal will sometimes try to rip a hole in the underside of the kayak, and many Eskimos are killed in this way. The hunter holds the end of the harpoon line and tries to pull the seal in close enough to kill it with his lance. I once struggled with a seal for about one and a half hours after I had harpooned it before I could

get it close enough to lance it and kill it. This seal weighed over half a ton. During the whole journey I got seven seals and sixty-one birds in my kayak. Of course I was only hunting occasionally, a total of about ten days' seal hunting on the whole journey. Apart from this we got a good many birds as we were going along in our boats." *Watkins. B.A.A.R.E.* 79.468.

"Seals must be the staple food for anybody proposing to live off the country in South-East Greenland. To procure seals in these waters it is essential to become an efficient kayak hunter. During the summer months if seals are killed while in the water they will sink at once. To prevent their sinking and so being lost, the Eskimo has evolved a method of harpooning them with the harpoon head attached to the bladder float. This cannot be done from a boat as the seals are too shy to come within harpoon range; so the kayak must be used with its protecting screen. When hiding behind this screen it is possible for a good hunter to approach within a few yards of a seal. The seal can then be shot and harpooned while it is sinking, or if the hunter is expert enough it may be only harpooned.

In Greenland on H. G. Watkins' last expedition we had a small supply of provisions, but we relied on the country to furnish us with the greater part of our food. We had no difficulty in providing for ourselves, but it occupied about half our time." *Rymill. E. Greenland.* 82.540.

"Living off the country was found to be quite easy at Bruce City, and up till early September it was always possible to shoot enough seals to keep the camp in fresh meat. Geese, duck, gulls, and, in September, ptarmigan were also obtainable: in fact at no time was this party without fresh meat."

Glen. Spitsbergen. 82.115.

"On the British Arctic Air Route Expedition we had learnt to hunt from Eskimo kayaks, and by adopting the Eskimo methods of hunting we proposed to live off the country, thus making an enormous difference to the cost of the expedition. This expedition was away for fifteen months and cost a total sum of £850. We found no difficulty in providing for ourselves, but it took us about half our time.

The salmon had left the fjord and gone up to the lake about September 13. We were not able to catch any more fish until November 20. By this time there was about 1 foot of ice on the lake, and by making a series of holes about 20 feet apart we were able to pass a net on the end of a long rope under the ice by means of a pole. Then, by breaking the ice on the two end holes we could pull the net in and out whenever we wanted fish. By using this method we had a supply of fresh fish all through the winter."

Rymill. Tugtilik. 83.365, 8.

"Although bread, milk, butter, and occasionally berries, can be bought in small quantities at the tiny Lapp hamlets along the rivers, it is usually quite impossible to supply a party of eight men adequately from this source. Butter can however be obtained at the larger settlements, and may be carried in the wooden butter-boxes sold in the country. . . . To bring dried milk is a waste of time, although it is quite suitable otherwise. Dried fish and dried mutton are good exercise to the jaws, but not very satisfactory. During the

second half of the expedition a good deal of wild fruit was obtained, chiefly bilberries of two kinds, and cloudberries.

Game is negligible as a source of food, since the party will be travelling during the close season, and there remains only the small supply of meat from scientific specimens shot under permit. Fish were obtained in several places, usually perch and freshwater herring (*Coregonus laveratus*), and it would undoubtedly be possible for one or two men moving at leisure through the country to obtain much larger quantities, given suitable tackle and sufficient skill. For a party of eight moving according to a schedule, it is probably out of the question to rely on any constant supply of fish."

O.U.E.C.3. Lapland.

"Porcupines are good to eat and easy to kill. Slow-moving and conspicuous, living on the bark of the Spruce Fir, and making white rings of naked wood. If it is feeding in the tree it may be shaken out, if hiding in a hole, persuade it to face you before you seize it. A sharp quill broken in the hand will work down deep. Loses flavour if skinned. The best method is to burn off the quills without singeing the flesh." *J. M. Scott. Labrador.*

"The coniferous forests of Labrador are 90 per cent. of the black spruce, *Picea nigra*, which grows equally well on the archaean hills and in the more swampy valleys. The tree is used locally for building and for firewood, and its leaves are boiled as a substitute for tea and for brewing a drink called 'spruce beer.'

Ground berries form almost the only fresh vegetable food in Labrador. They grow thickly on the burnt land and also in the marshes, and are gathered in the autumn and in the spring as soon as the snow has melted. Round Hamilton Inlet the most common are two species of Vaccinium—*Vaccinium vitis idaea*, known as the red berry; and *V. caespitosum*, the blue berry. The bake apple, *Rubus chamaemorus*, is also common, and another species, *R. stigosus*, is found in clearings in the woods." *Watkins. Labrador.* 75.115.

The sour curds of the Pamirs are very nourishing, buffalo and yak milks are very rich, and yak cream like Devonshire cream. Yak butter, often described as rancid, should be considered as cream cheese: it keeps very well wrapped in skin. The M.E.E. Reconnaissance Expedition 1935, under the leadership of Shipton, found it a pleasure to live on Tibetan food on the way home, though remarking that high-altitude flour, full of grit, produces diarrhoea. Any cheap native-ground flour may contain grit from grindstones: better qualities mostly free.

In Central Asia barley parched and ground (tsampa) is eaten mixed into a paste with butter and tea, but is better and more digestible boiled with dried milk and eaten with sugar as porridge.

"The most important item in our food supply was *tsampa*, which we ate for breakfast and lunch for three months and which did not need cooking. It is roast barley meal which is eaten by soaking it in tea with rancid butter.

After lunch I used to go out with a ·22 rook rifle. I was very lucky all the time, for I usually got a goose, or a hare, or a pheasant, or mandarin duck. The last is not generally considered fit for human consumption, but it is actually very good." *Fleming. Koko Nor.* 88.135.

In Chinese Turkistan ample supplies of native food are usually obtainable, with Russian sugar. In Mongolia and Eastern Tibet little *en route* except sheep and sometimes milk and butter. Purchase rice, flour, condiments, dried fruits and vegetables, potatoes in the larger centres. The dried fruits well soaked are in the long run better than tinned. In the Chinese interior there are more game birds, especially pheasants, than in any other part of the world. Carry a stout 12-bore such as the B.S.A., No. 5 shot cartridges, with B.B. for larger game birds and wild fowl. In China proper a rifle little use, but a small-bore in Mongolia for antelope.

"At midday we stopped for lunch at a more than usually fairy-like temple where we ate the regulation meal of *kua mien*. Our meals for the next five days consisted of this substance, which is very good indeed: it is a kind of spaghetti, bought at the wayside for a few coppers, which you eat with a great deal of red pepper." *Fleming. Kansu.* 88.132.

"In Sinkiang native produce is cheap, abundant, and suitable for travellers. Good wheaten flour, maize flour, and rice; dried fruit, especially apricots, and honey; excellent peaches and nectarines; various grapes, nearly always good; walnuts in some places; raisins and good sultanas. Butter scarce, should be bought in a large skin when visiting Nomads. Milk scarce, unobtainable in winter. Potatoes scarce. Other vegetables rather uninteresting except where, as at Urumchi, there are Chinese market gardeners: beans, turnips, carrots, egg-plants, cucumbers, marrows, spinach, Chinese cabbage, frequently tomatoes, sometimes French beans.

At regular weekly bazaars in all towns and villages matches, sugar, tea, candles, common but smokable cigarettes, and paraffin, can be bought nearly everywhere; largely Russian sugar, not bad, rest indifferent. Hennessy's Three Star brandy obtainable in a few large towns, the only safe alcohol. Tinned fruit and fish usually dear, old, and indifferent: best avoided." *Schomberg.*

On south-east border of Tibet there are maize to be ground for chupatties, hill rice dry and glutinous for curry, millet and buckwheat for porridge, eggs and chicken (tough), milk in western but not central or coastal China.

"Tahawndam itself comprises three Tibetan families, whose wooden single-roomed cabins, thatched with grass, stand amidst permanent cultivation in the valley bottom, at an altitude of 6000 feet. These people possess herds of half-bred yak, and goats, which furnish them with milk and butter; sheep, pigs, fowls, and two breeds of dog, the ordinary Tibetan mastiff

watch-dog (smaller than those commonly met with in Tibet), and a small smooth-coated prick-eared yellow dog used for hunting. Yak are yoked to the plough. The Tibetans also hunt gooral, serow, and barking deer, and collect wild honey. They cultivate barley, oats, maize, buckwheat, millet, peas, and beans. In fact they live extremely well."

Kingdon Ward. Burma-Tibet frontier. 80.469.

"We found wild strawberries and raspberries in profusion, and pear, peach, and walnut trees, though the last three were not in fruit. Rongyul, about 6800 feet high, is the most northerly village in this part of Zayul where rice is grown." *Kaulback. S.E. Tibet.* 83.184.

"It is always possible to get butter and milk in Tibet, and the older I get the more easy I find it to live on milk. In fact, in my fiftieth year I lived chiefly on milk just as I did in my first year. We did not get very much meat. At the higher altitudes the people do not keep chickens, and there is no other domestic bird which lays edible eggs. Yak are very common in Tibet especially at high altitudes, but they are too valuable to be killed for food. Occasionally a yak dies, and then meat is available."

Kingdon Ward. 88.413.

In East Africa there are game birds and sometimes meat. Buy sweet potatoes and sometimes manioc from natives, avoiding the bitter manioc. Purchase a sack of English potatoes and sometimes onions in most towns. After rains much wild spinach; but get followers to identify it as edible. Sheep and chicken (often tasteless) in many places.

"The staple food is kafir-corn, *mopira*, as it is called here, and *amabele* in South Africa. It is a form of millet and the head is cut off when nearly ripe, dried, threshed with a stick, and ground into flour by pounding in a mortar, and finally by rubbing with one stone against another. . . . Other crops grown are a very small millet for beer, and kasava or manioc. The latter is grown mainly as a standby, and as luxuries we find sweet potatoes and beans, usually tree-beans. All forms of flesh are eaten when opportunity occurs, even rats, mice, snakes, and dogs. Rice is like best of all, but is grown only in a few districts. Salt is the principal requirement from outside sources, and quantities of supplies such as flour, eggs, and fowls can be purchased for a few spoonfuls of this commodity." *Vincent. Port. E. Africa.* 81.323.

In tropics generally employ local hunters and fishermen, and encourage natives to bring food for barter or sale: yams, taro, manioc, rice, breadfruit, bananas, oranges, limes, and interesting nuts and fruits at different seasons.

"Living for four months in the forest made it advisable to get fresh food. One of our Indians was detailed as a hunter, supplied daily with gun and cartridges, and sent into the forest to shoot game. He proved very successful where a European would find little or nothing. His best animals were tapir, with flesh like that of horse; paca, which reminded one of pork; and forest

deer which made quite good venison. Also he brought in many agoutis, and on most days excellent birds. He almost kept the camp supplied with a sufficiency of fresh meat. It would be useful to a party continuing this work to know how much meat a patch of forest can produce. We were camped in it for 105 days, during which time the hunter brought in 1 Tapir, 1 Red Deer, 3 Paca, 27 Agouti, 18 Pigmy Agouti, 18 Curassow, 33 Guan, 30 Great Tinamou, 32 Small Tinamou, 16 Partridges, and 7 Trumpeters.

Fish, on the other hand, was very scarce. All the creek supplied were a few small Kurumaya and two large Haimara. I was surprised at the scarcity of edible plants and fruits. All this varied and luxuriant vegetation produced very little fit to eat. A small yellowish fruit, *Redia*, had a flavour like a rancid grape; a few Sawari nuts were a little like Brazil nuts; the heart of the common Turu palm could be made into a kind of cabbage. But these forms of food were scarcely worth collecting and the traveller in this bush must place no reliance on the expectation of finding either green vegetables or fruits."

Hingston. British Guiana. 76.9.

"All natives eat mainly rice, with some salt fish and meat; we ate mostly rice, pigs, hens, eggs, potatoes, onions, and bananas. We managed to get over one hundred wild pigs by shooting and spearing, with the help of two brilliant hunters, Subai (a half-Dyak) and Murah, both from Long Miwah. Barking deer, rusa, and mousedeer were obtained in small numbers, perhaps twenty in all. Turtle was attempted, but it was very tough. The Kenyahs and Sĕbops enjoyed monkeys, especially a leaf monkey, *Pygathrix hosei*, which was quite common and tasted very like pig. Bulwers, Argus, and fire-back pheasants were caught in long lines of snares set in gaps along an artificial hedge; hornbill was a popular native dish, but we found it unpleasant. Fish were caught in the curious native throw-nets and by "tuba-fishing," in which a part of the river is staked off and a semi-poisonous vegetable juice floated downstream in large quantities so that the stupefied fish come to the surface and are easily speared or caught in the hands. We ate somewhere near four hundred hens, mainly brought up by Chinese traders from Marudi, average cost one shilling. Pemmican and plain chocolate were found to be excellent tropical foods. Two cases of delicacies and whisky proved psychologically invaluable after a bad week." *Harrisson. Sarawak.* 82.390.

"Nearly all these animals were used by us as food, as were also white ants fried on buttered toast and Monitor Lizards in curries. This diet, combined with fresh native vegetables gathered in the bush, probably accounted for our good health." *Sanderson. Cameroons.* 85.125.

"The greatest difficulty in S. Arabia was the absence of milk, fruit, or vegetables. The dates were almost uneatable because of flies. Where procurable, sour milk (*Seban* in Syria, *mast* in Persia) is excellent as it preserves against dysentery and such troubles: a little of it mixed with water makes a refreshing drink and is particularly advisable if the water is suspect. 'Living on the country' in Arabia is apt to lead to under-nourishment."

Freya Stark.

"On March 5 all was ready and the camels came in for a final drink. The baggage folk, returning to Riyadh, went off first, and at sunset we ourselves

started—eleven men and the dog with fifteen camels carrying twenty-four skins of water and the dates and raw dried camel meat (not salted), which were to constitute our sole diet until we reached civilization. No water could be spared for cooking, so we carried no rice. The raw meat was pleasanter than it may sound, and certainly provided the energy we so badly needed, while I had annexed a few onions from the kitchen and also had a large tin of peppermints to suck on thirsty days." *Philby. Rub' al Khali.* 81.19.

"I found that a camel could carry nine days' food for my men, but I was able to supplement their rations fairly regularly with meat. It is impossible to obtain any grain, vegetables, or even eggs from the Dankali, except at Aussa, where some *durrah* is cultivated. They live exclusively on meat and milk, and their greatest delicacy is *ghee* and *berberi* (red pepper), mixed in curdled milk." *Thesiger. Danakil.* 85.3.

"The oranges of Dakhlat will one day be famous. When fresh they have a fragrance that must be experienced to be appreciated. I bought a hundred of them on the spot for two shillings, and thought them worth that apiece." *Orde Wingate. Libyan Desert.* 83.288.

"Occasional Bushman stads were encountered, and, very rarely, a few head of cattle. Here apparently the Masarwa Bushmen roamed in absolute freedom, their diet, except when amplified by the hunt, consisting entirely of berries and the flour-like substance which grows round the beans inside the immense pods of the baobab tree. On inquiry we were informed that the ownership of the fruit of these trees is by no means promiscuous. It is in many areas strictly prescribed, certain trees being recognized as the property of definite families of Bushmen." *Clifford. Kalahari.* 75.19.

"The further we left the coast behind the less clothes and steel implements appeared among the people. The Brugap people possessed little calico indeed, and we saw few steel knives; but although they were camera-shy, they brought an abundance of food in return for salt, razor-blades, and bright-hued rings which we traded. There was never difficulty in securing food: always the graceful young women, and a sprinkling of withered old hags, appeared in the afternoons loaded with sago, yams, taro, sweet potato, and native vegetables to trade." *A. J. Marshall. New Guinea.* 89.494.

"After one meal off the ram the carcase began to putrefy, although neither Tuareg nor Arabs appear to mind eating green, rotten meat." *Donkin. Sahara.* 83.403.

EDIBLE FOREST PRODUCE

In tropical or sub-tropical forest one is certain to find fruits and vegetables to supplement the diet, and to supply necessary vitamins. Rely on the natives to distinguish between the edible and the poisonous. Carriers on the march will always stop to collect edible fungi, fruits, leaves, or shoots to garnish their rations.

There are five more or less distinct tropical floras, those of south-eastern Asia, northern Australia and New Guinea, east Africa, west

Africa, and tropical America. Look into such books as Rodney's 'In the Guiana Forest,' and Belt's 'Naturalist in Nicaragua' for tropical America; and Hooker's 'Himalayan Journals,' and Wallace's 'Malay Archipelago' for tropical Asia. A few examples of wild diet, found in the hill jungle of Assam and Burma, may stimulate the inquiring traveller to note carefully what he finds eatable and any reactions.

There are many different wild raspberries in the eastern Himalaya, all edible, mostly ripe in the spring, but a few later; cherries often astringent, but palatable; crabs; and strawberries in the hills. The common fig is one of a large assemblage, mainly confined to the eastern tropics, where several have edible, even pleasant, fruits. Wild mulberries are not uncommon. I have eaten and enjoyed a *Garcinia* (the mangosteen is a cultivated species of this; gamboge is obtained from another species); *Saurauia*, an easily recognized tree with sweet pulpy fruits; a *Diospyros*, belonging to the ebony family; *Actinidia* and *Akebia*, two woody climbers; and semi-wild Citrus fruits. Most jungle berries however are bitter, or poisonous, or both; though several alpine Vacciniums are excellent.

In the hill jungle and temperate rain forest, say between 5000 and 10,000 feet altitude, bamboos occur in great variety; and the young shoots, up to a foot high, thrown into the embers for ten minutes and then stripped of their outer burnt leaf sheaths make a good vegetable. Of underground parts the most important are "yams," the tubers of various species of *Dioscorea*; in times of famine, some Burmese jungle tribes, who can find them even where nothing shows above ground, live on them. In the higher forest zones, wild garlic leaves (*Allium;* there are several species) furnish a useful vegetable and garnish, but the bulbs are hardly worth digging up. On the other hand, going yet higher, Fritillaria bulbs are. The leaves of several forest herbs furnish a sort of spinach.

More palatable are some of the edible forest fungi. Some are gelatinous and rather tasteless; but in the alpine forests of Burma I found a pleasant-tasting fungus growing on fir trees so high as 12,000 feet. The famous bird-nest (soup) of the Chinese is made of a lichen used by the swifts of the sea caves to build their nests; on boiling it became gelatinous. Wild honey is common in the Burmese hill forests but in spring is made mainly from the flowers of Rhododendrons, and is toxic. Various insects, especially in the larval stage, and bugs are eaten by the jungle tribes; they are quite palatable.

The casual auxiliary diet of jungle tribes has been little studied, and offers a rich field to the patient investigator. The curious traveller will

nibble anything which promises good results, and with reasonable caution is not likely to come to much harm. My own worst experience was to chew a morsel of the rhizome of an *Alpinia* (member of a likely-looking family to which ginger belongs), with disastrous, and had I swallowed it probably fatal results, for the rhizome contained much powerful alkali, which badly burned lips and tongue.

F. Kingdon Ward.

"The bamboo shoots were ripe for eating, a fact which undoubtedly saved us from a very serious predicament. We were also able to collect a small supply of forest-mushrooms, which, though they did not last long, gave us one or two square meals." *Shipton. Nanda Devi.* 85.316.

WATER SUPPLY

Always camp above a village but remember there may be another village higher up and out of sight. Boil in a pan rather than a kettle, skim off the top or strain, or filter through porcelain-candle filter fitted with a pump (Berkefeld filter made at Town Mills, Tonbridge, Kent).

Glacial mud does not settle quickly and is very irritating to the stomach.

Learn the technique of finding water in beds of streams, digging wells in desert, finding fresh springs on shores of salt lakes or of the sea. In glacier travel prefer to camp just below the snow-line to ensure water. Remember that pools on the surface of sea-ice are generally fresh; that melting ice or snow for water uses twice as much fuel as the cooking that follows; that eating snow makes you thirsty; that ice melts very much easier than snow, and if snow must be melted fill the pots from a well-consolidated lower stratum. Tilting the pot makes easier melting.

Practice drinking only morning and evening. Do not sip water on the march, but consider the waterbottle as for an emergency only. If possible carry oranges to relieve thirst by day, and remember that melons carry any infection of water. Remember that the vacuum-jacketed vessel from which the thermos flask is derived was invented to keep liquid air in, not hot coffee; therefore fill a thermos at night to keep the water cool for the following day. Similarly fill one thermos at night with cold tea for the march, but never mix milk with it; and another with hot tea or coffee for an early breakfast.

Well water may come from deep or shallow wells, the latter as a rule the dirtier. Deep wells in the desert may be caravan or pasture wells: if

the former passing travellers usually have the right to use them if at peace with the tribes in the neighbourhood; if pasture wells, caravans have in theory only a claim after the needs of local herds have been satisfied. No one will refuse a thirsty traveller water, but he is expected to use public places of refreshment for his needs, rather than private houses as of right. Well ropes are essential for safety, and preferably should be two, since some wells, by constant widening and excavation, and some deep pools are such that water can be drawn only by hoisting the bucket from opposite sides, to prevent spilling against the walls.

The common native bucket, a circle of leather laced to a ring, is as efficient as any European bucket, metal or canvas; it is easier to fill, to make and to mend; and can be made in any size, large enough even to hold several gallons hoisted by men tailing on to a rope run over a pulley or smooth bar of hard wood. Take the temperature of water in deep wells as a guide to mean annual or seasonal temperature.

Water pools give the worst water. Unless very inaccessible under boulders or in fissures of rock they are nearly always foul with excrement of wild and domestic animals, except just after rain.

The best water of all is found in sand or earth scrapes, held below the surface by some rocky sill. It is saved from contamination, and from the larvae of insects, and is at any rate partially filtered as it seeps through the sand. But unless near the surface it is laborious to get; may require considerable digging; and in sandy country the holes are rapidly filled in as the water, seeping in, breaks down the side. On the other hand, it is this very factor which maintains the quality and supply. If in spite of being wetted all round the sand flows into the hole so quickly that not more than a few ounces can be got at a time; build a sort of circular retaining wall of stones, sticks, and cloth: most effective in certain cases.

Before leaving always cover up a sand scrape after use, if it has not already covered itself up, to preserve the supply for those who come after. Always replace stones on well mouths, to prevent them silting up. A water supply in the desert is even more sacred than a palm tree.

Francis Rodd.

CHAPTER VI. CLOTHING

Clothing is so much a matter of taste that it is impossible to be dogmatic. But we may begin with certain specialist questions of windproofs, furs, protection against sun, and proceed to their applications in choice of clothing for polar, mountain, desert, and tropical travel.

WINDPROOFS AND WATERPROOFS

The questions of weave have been discussed already in the section on Tents (p. 31). Modern experience shows that cotton windproof materials are generally preferable to furs; that wool is little use against wind; that a good form of garment is the Greenland *anorak* (Eskimo "against the wind"), which is a combined pullover and hood now much used in ski-ing and sailing, as well as in sledging and climbing. Remember that new clothing is warmer than old, and that grease or oil on windproof destroys its protecting quality.

Wordie cloth (see p. 33) was the principal windproof material used by Watkins and by Lindsay in Greenland, Grenfell cloth by Glen in North East Land and by recent Mount Everest expeditions; Rymill in Graham Land used both. The former is said to be more durable, but is not so easily obtained, since it is woven only to order. The M.E.E. 1933 used also Jaqua (Camp and Sports), which they found stronger than Grenfell but less flexible.

FURS

Furs are heavy, difficult to dry, and deteriorate rapidly. They are difficult to make and repair unless Eskimo seamstresses are available. The Eskimos themselves are rapidly taking to European clothing, and will lose the art. But so long as Eskimo clothing can be obtained it is excellent for many occasions, especially when working from houses with stoves at which it may be dried. The Eskimo *anorak* is made from the thin skin of a seal's stomach. Eskimo boots of tanned sealskin, breeches often of bearskin, gloves of sealskin lined with puppy-skin.

HEAD-GEAR

The Balaclava helmet is worn from the Poles to the Arabian deserts, where it is very cold at night. It may be knitted on the end

of a long woollen scarf. On camels, away from civilization, Arab head-dress is excellent: the best form is a large square of soft brown wool, cool by day, warm by night, shade from the sun, useful in sand storms, and as an emergency mosquito net, but not so good against glare. Wear so that a corner protects back of the neck.

To keep the head cool in the sun, to shade the eyes and reduce glare, topees are worn in India even in the Himalaya, but no longer in Ceylon or in Java, and never have been in many parts of Africa. The topee takes an hour to warm up and therefore is good for a short walk. Whether it is the best thing to wear all day seems more doubtful. Some go so far as to speak of "the topee superstition." A useful rule is to wear them where others wear them, but not in countries where others find them unnecessary, and the Terai or Homburg hat is sufficient.

If the topee is worn, consider the great advantages of lining with aluminium foil. Experiments by Dr. G. P. Crowden (*The Lancet*, 6 January 1934) showed no advantage in the usual non-metallic helmet linings of red, green, or khaki, but if aluminium foil is stuck to the inside of the helmet the heat radiated to the head is reduced to one-tenth; and a second or drop lining of fabric coated with aluminium foil on both sides made still greater improvement, provided that the space between is well ventilated, the head band being separated from the helmet by a ¼-inch air-space. Temperatures measured by thermopile ¼ inch above the scalp showed 8 to 10 degrees cooler with the aluminium lining.

British surveyors in the Himalaya, finding it inconvenient to observe in a topee, sometimes wear the Pathan *kulla* (cap) and puggaree; good against the sun and comfortable in camp. In arctic mosquito country wear a stiff-brimmed felt hat to carry the net; otherwise in summer a deer-stalker probably best.

FOOTGEAR

Heavy and expensive leather boots might be worn very much less than they are while on the march and saved for actual climbing. Crepe-rubber soled shoes were worn all the way to Rongbuk by one member of M.E.E. Reconnaissance Expedition 1935, and afterwards on low and dry ice tracks: good also on dry rock, but useless on wet, steep ground. *Chaplis* (sandals) with leather socks are good for rock and grass slopes, but Kashmiri grass shoes are not recommended.

Ski-ing boots nailed on the edges, and two pairs of socks, do well in Himalaya with Gilgit woollen boots to the knee in camp at night.

The M.E.E. 1936 took climbing boots by J. S. Carter, 16 South Molton Street, W.1, and high climbing boots lined with fur by Robert Lawrie, Ltd., 38 Bryanston Street, W.1; also lambskin camp boots by Clark Son and Morland, Ltd., Glastonbury, Somerset. The skins for the latter have to be specially cured, and several weeks should be allowed. The Sudan fashion of polo boots with shorts is highly commended.

For walking in deserts some recommend native-made sandals with flat soles, one thong between the toes and a strip over the instep; but they must fit. Others find the thong irksome. Camels may be ridden with bare feet if not ticklish, or in thin rubber-soled canvas shoes, or leather sandals protected at the toe, or in *chaplis*.

Leather sea boots are better but more expensive than rubber; good sea-boot stockings well greased. The Danish Traeskostovler with wooden soles and leathers up to the knee are good in cold weather.

Leggings should not be worn on the march. Fox's spiral puttees are better. The M.E.E. 1936 wore Cashmere puttees by Arthur Beale, 194 Shaftesbury Avenue, W.C.2. Many prefer short ankle puttees. For tropics some like mercerized cotton puttees.

Skis are used increasingly in the Himalaya and the Rockies for return to camp from observing stations, or for crossing passes; also for sledging with dog teams. Snowshoes are used instead when snow is soft, or through woods, as in Labrador.

"On nearly all long journeys it is best to take both. Conditions vary so greatly that one day it will be best to use snowshoes and the next to use skis. For skis the only fastening necessary is a strap over the toes. It is important that they should be kept well waxed, or the friction on dry snow will be very great. Snowshoes should not be of the wide Indian pattern but narrow and rather small. If it is quite certain that there will be no damp snow in the whole journey, then they should be knitted with fine deerskin, otherwise sealskin is better. Snowshoes are absolutely essential on new deep snow, since the dogs will be unable to haul the sledge unless the men walk ahead to make a track. A track made by skis is almost useless." *Watkins. Labrador.* 75.114.

"Because the snow in the woods is always soft and never windblown, we had to wear large Indian snowshoes, like vast unwieldy tennis rackets."
J. M. Scott. Labrador. 123.

"We passed through this gateway to Forel on the sixteenth day after leaving the base, having travelled on thirteen days and covered a distance of

176 miles. Apart from the three days when we had to lie up the weather had been warm and sunny, but the surface was soft, and we had to wear snow-shoes every single day—excepting the man who went ahead on skis. Skis were undoubtedly the best method of travelling, but the surface was still considerably cut up with wind-drifts, and it is impossible to manipulate dogs and a sledge over such a surface when wearing skis."

Stephenson. B.A.A.R.E. 80.9.

"The hours on ski in front of the party were the best on the ice-cap, except those spent eating. One could for a time get away from sledges and dogs and be alone with one's thoughts. Ski were worn for 950 miles; without them the journey could not have been undertaken." *Lindsay. Greenland.* 85.399.

"In 1930–31 our ski had all been made of hickory. Several people suggested that I would be well advised to take ash ski, as being lighter and strong enough for our purposes, but when it came to weighing them I found there was no appreciable difference between the two, so we remained faithful to hickory. Hoygaard, who had crossed the Ice-cap in 1931, advised us to treat our ski in the following manner, which was faithfully carried out: let them dry; paint them with a mixture of 3 parts linseed oil to 1 part wood tar; let them dry some days at a temperature of about 110° F.; repeat this procedure 4–5 times. Hoygaard told us that if we did this there would be no need for ski-wax.

The ordinary metal binding cannot be used, as it is too cold to wear leather boots with fixed heels. The ski-binding for a sledge journey has therefore to be a type of boot, into which one's foot in its moccasin fits tightly. The binding has a strip of leather round the heel and a leather strap across the instep; the rest of it is made of thick canvas which folds round the ankle and is then bound tightly. This type of binding was invented by John Rymill for Watkins in 1930. I improved it for our journey, and Rymill, I believe, afterwards improved on my modifications for his own expedition."

Lindsay. 'Sledge.' p. 79.

"Skis . . . proved most valuable. They were, with the exception of one pair, cheap ash ski, and for hauling were superior to the one pair of expensive hickory ski that we had. Having more friction they do not slip back on hills, where the hickory cannot be used at all without skins. For steep hills we used artificial skins, which were excellent, and did not slip back even when the slope was as steep as the foot would bend back to. We had not thought that it was possible to pull strongly on ski, but we found hauling to be perfectly satisfactory although none of us was an expert."

Courtauld. E. Greenland. 88.206.

DARK GLASSES

Grey is a depressing colour, and orange much better, except perhaps as in Central Asia where landscape is bright in colour. For high climbing and sledging on snow, goggles are always preferable to glasses, since principal glare comes up from below. Crookes glass cuts out ultra-violet. Goggles must be well made and fitted to the individual: M.E.E. 1936 supplied by Theodore Hamblin, Ltd., 15

Wigmore Street, W.1. Avoid cheap glasses, and especially celluloid, which passes ultra-violet rays and produces snow blindness; the cheap Japanese goggles sold in Indian bazaars come apart almost immediately.

Carry a large supply of dark glasses for porters and coolies, but take back into store when not actually in use. Lines of communication over snow passes may be disorganized by snow-blindness among the men. In Tibet dark glasses make useful presents.

If goggles broken use strips of unplaited horsehair or of mosquito curtain or fine muslin blackened; or thin card with slit or cross slits (as in primitive Eskimo goggles).

Some consider the use of dark glasses in deserts a habit much better avoided, rarely as necessary as supposed, and that they should be carried in reserve, but not used at the start, as once used they are more necessary: or take glasses of two strengths and wear the lighter as long as possible. If spectacles are worn, consider having them combined with the goggles.

"The only thing which worried us was the excessive glare from the level expanse of snow. Our lips especially became in very bad condition so that we had difficulty in eating our salt pemmican. Only the best quality snow glasses were good enough to protect our eyes, and some who wore celluloid goggles were troubled with slight snow blindness, and unfortunately we had not brought any of the special ointment necessary to protect the skin."

A. Courtauld. East Greenland. 88.201.

POLAR CLOTHING

The modern principle is to wear thin clothes and plenty of them; layers of moderately thin woollen underclothing; several very light sweaters (such as made by Mrs. Duncan, Scalloway, Shetland) and outer windproof; camelhair underclothing in winter. Flannel trousers are better than knickerbockers and stockings; short puttees round the tops of boots; moccasins or *finnesko* in winter with several pairs of duffle slippers inside.

In winter dog skin (native) or wolf skin (Norwegian) outer gloves are warmer than horse-hide; woollen mittens under the outer gloves, and woollen gloves under the mittens. In summer soft horse-hide and canvas ski-ing gloves, fingerless with long gauntlets and separate elastic band: such as supplied by Lawrie, 38 Bryanston Street. Fit the gloves with lamp-wick harness so that they can be removed and carried as in Shackleton's statue outside R.G.S. House; or pin

on with large safety-pins, of which plenty should always be carried. Separate gloves are more easily dried than skin gloves lined. For observing, use chamois leather fingered gloves.

Spare clothes are carried in rucksacks lashed on top of the sledge load. Mark all clothing plainly with initials, and arrange for socks to have distinctive coloured tops.

Furs are quick and easy to put on and off; according to Stefansson they localize the hoar frost; and they can be obtained locally from Eskimo or even off the country. But they are hard to keep in good condition and at the best last only one year and except to Eskimo women are difficult to make or repair. If they get wet either by condensation or thawing snow they are very hard to dry. Good for North American conditions where one travels from house to house or anyhow has plenty of wood for drying.

Thin woollen or blanket clothes and canvas-type windproofs are much easier to dry with limited fuel, and are very easily repaired; do not deteriorate if wet, and last longer than furs. The best windproof material seems to be something like the Burberry, or the Wordie cloth, which is much stouter than the Grenfell: the latter too fragile for long rough work, and not so waterproof. Any material is much improved by being rubbed with blubber. The windproof suit should have elastic at the wrists and lampwick round the ankles if puttees are not worn. It must fit at wrists and ankles as a diving suit if it is to keep out drift snow. Most prefer a band of fur round the inside of the hood at the front; a hard line of hood embracing the face may cause frost-bite. The hood must fit fairly tight or the ears get cold when facing into the wind. Double windproofs are far too heavy and hot, and do not localize the hoar frost at all. Windproofs must be light, for often one does not wear them, but they must be carried everywhere in case a wind or blizzard gets up at short notice.

Moccasins have a very limited use, in the soft snow of Canada or inside a winter ski-binding. They are far too thin for the crust and rocks in the rest of the Arctic, or for walking without ski. For cold weather *finnesko* are probably best; Sennegrass and duffles and thin socks complete the footwear. Norwegian trappers use a boot of many socks sewn together, in canvas uppers with a rubber sole: good for house-to-house work where plenty of drying is possible.

For warmer conditions *komager* or *kamiker*, the Lapp and Eskimo types of tanned sealskin boot are best, and are waterproof. Above $+15°$ F. Lawrie's boots are good, and we found them warm enough unless one was standing about very much. Fur-lined boots are warmer, but almost impossible to dry. There is no solution to the problem: to

find a boot for all temperatures from above freezing to -40° F. For summer work, with boots, thicker socks are better for they do not get holes so easily and are easier to darn.

We used the same gloves as Lindsay, but of better shape, with longer fingers and thumbs. The hand should just touch the glove between forefinger and thumb, and there should then be plenty of room beyond the finger tips: otherwise they get frost-bitten. Each glove is sewn together from three pieces of material—I got the design from Greenlanders N.A.C.C. The palm should be cut smaller than the back.

Double gloves are a nuisance: difficult to pull on and off, but easier to dry. Recommend single thick gloves. Very few things cannot be done in gloves nearly as quickly as with bare hands. If everything that can be is done in gloves, the hands are warm for the few jobs that need bare fingers, and frost-bite is avoided.

Lindsay and we used chrome leather outers with blanket cloth or camelhair inners. The Greenlandish or N.A.C.C. skin gloves are good for coastal sledging in cold conditions; seal-skin outers (with fur outside) are used with puppy-skin inners (with fur inside), and this combination is ideal for warmth. Hoar frost must, of course, be scraped off at night time and the gloves then hung up to dry. I found woollen finger gloves even better than silk for theodolite and photographic work. *J. W. Wright. Northeast Land.*

Both Rymill and I think skin clothing is very good for a hut to hut or igloo life in a dryish climate like the N.W. coast of Greenland. We are very much against skins for long journeys, because: too much snow is brought into the tent; the skins are too difficult to dry; the skins form too much ice on them and become proportionately heavy; and it takes at least two years getting to know how to wear skin clothing and how *not* to get over-heated. I used skin clothing during my eight months on the West coast of Greenland. Bear-skin trousers are delightfully comfortable and fairly porous. Seal-skin trousers are almost non-porous, and I always had to scrape the hoar frost off the inside of them—I do not recommend them at all; Eskimos did not o course have much of this trouble, as they knew how to keep an even temperature.

The warmest gloves I know are made of puppy skin inners (hair facing the hand) and seal-skin outers (hair facing outside). The palm of the glove should be cut very much smaller than the outside, so that, when the hands are gripping something, the inside tips of the fingers do not press too much on the skin of the glove and get frostbitten or cold. Long loose-fitting mittens indispensable for theodolite and photographic work. *Note by Andrew Croft.*

"During the Ellesmere Land Expedition, we were fully equipped with manufactured wind-proof garments of every description, and after fairly exhaustive tests, the members of the expedition all favoured skin clothing. . . . The most important factor is that clothing of deerskin is both lighter and warmer, and therefore, for winter and spring sledge journeys, more suitable. For temperatures above zero, such as are encountered by summer expeditions, cotton wind-proofs are entirely suitable, particularly so when the sledges are man-hauled. The main essential is to obtain the right kind of skins. These we ordered through the Greenland Administration, and they were from full-grown deer, autumn killed, whereas fawn skins are really necessary for satisfactory skin clothing. However we followed the example of the Smith Sound Eskimo, in whose country the caribou is now almost extinct, and who in consequence obtain their skins from Lapland through the Greenland Administration. Although their clothing is not quite as good as that favoured by the Baffin Land Eskimo, who rely entirely on caribou skin, it is however very satisfactory.

We wore sealskin boots with soles made of bearded seal skin (*Erignathus barbatus*), sheepskin stockings, and sometimes an ordinary pair of woollen socks. Between the sheepskin stocking and the sole of the boot a pad of grass, or failing this, a deerskin sole is inserted, and enormously increases the effectiveness of the insulation. The most important factor is to wear the minimum of clothing necessary rather than the maximum, since excessive warmth leads to perspiration, and therefore to frost bite. We usually carried also a pair of overshoes made out of either deerskin or bearskin, which were useful if ever the feet became too cold, as sometimes happened when camp was being made. The tops of the stockings were sometimes trimmed with bearskin, and above this was wound a band of sheepskin to cover the joining between breeches and boots. Those of us who were able to obtain them wore breeches of bearskin, which we found more suitable than the breeches made out of deerskin we had brought with us. Some of us also wore cotton or moleskin trousers, but these, on the whole, were not as warm and convenient.

In the coldest weather we wore deerskin hooded coats, known as *kuletas*, which were tremendously light and warm, but they were rather clumsy, owing to the nature of our skins. Wind-proof hooded coats of either Grenfell or moleskin, of which the hood and wrists were trimmed with fur, over an inner coat of duffle, were found satisfactory. Underneath, in the cold weather, we usually wore a small, cotton, hooded *anorak*, a Mackinaw shirt or icelandic sweater, and a couple of vests. Balaclavas were generally disliked owing to the fact that they are inclined to induce sweating round the neck. With a proper hood, an ordinary woollen knitted hat to cover the ears (preferably wool of a non-hairy nature), or better still a fur cap with ear pads, were found to be more satisfactory. Of the other items of clothing sealskin mitts with sheepskin linings were found to be satisfactory, though probably not as warm as dog or wolf skin. These should be trimmed with fur, which then fits against the fur trimming of the wrist of the sleeve. The result is much more satisfactory than the gauntlet type of mitt. A pair of woollen gloves is sometimes useful for untangling the dog-lines or for doing odd jobs for which the fingers are necessary. But generally speaking by separating the fingers gloves tend to reduce the warmth of the hand, even inside a mitt, and for ordinary purposes should not be worn at all." *E. Shackleton. Ellesmere Land.* 87.435.

"Fur clothing was not used, sheepskin being taken as a substitute, in addition to windproof suits of Grenfell cloth. The windproofs were double, which was a mistake, as they were too warm for hard sledging. They were also unnecessarily complicated, and zip fasteners were considered unsuitable for the conditions met. It is better to use several light anoraks, as the secret of comfortable travel lies in the maintenance of an even temperature. Anoraks can be stripped off, so that there is no necessity for becoming either too hot or too cold. Light Shetland jerseys, flannel shirts and pyjamas, and Braemar silk and wool underclothes, proved excellent in all conditions. Short ski socks, specially knitted by the Lexden Village Industries, were much more satisfactory than the Austrian skiing stockings, which were often difficult to dry. Climbing boots with sheepskin linings were used in the summer, and Lapp Kommager and Finnsko during the rest of the year. An adequate supply of saenna grass was taken. The excellence of the clothing was well demonstrated by the fact that despite continuous travel throughout the whole year, and the prevalence of blizzard, no case of serious frostbite was recorded."

Glen. North East Land. 90.194.

For winter sledging, West Greenland, 1935: "Croft's clothing consisted mainly of the standardized polar sledging dress: a Jaeger camel-hair suit and ski-ing helmet, with a thick polo sweater underneath, a wind-proof suit, innumerable gloves, socks and duffles (blanket slippers), finnesko (fur-boots), and snow glasses. This could be supplemented if necessary with bearskin and sealskin clothing and sealskin boots, made by the natives.

For summer sledging. Greenland Ice-cap, 1935: "Except for gloves, everything was copied from Watkins. . . . Our clothing consisted of wool or silk underwear, two thick sweaters, and a Jaeger blanket-material suit. On our feet we wore two or three pairs of thick socks, and on top of them two or three pairs of duffles. Outside there came the moccasins obtained, together with the snowshoes, from Canada through the Hudson's Bay Company. We wore Jaeger wool ski-ing helmets, and on top of everything came closely-woven cotton suits of windproofs." *Lindsay. Sledge. pp.* 28, 78.

"Maria will make me a pair of sealskin trousers, which it is essential to have on long winter journeys. When it is especially cold I shall be wearing my Jaeger flannel trousers and then sealskin trousers above them with windproof trousers over both the other pairs. I have now sufficient clothes for my body and head; warm thick polo sweaters, a heavy Jaeger flannel coat, and a windproof blouse which also has a hood to place over the top of my Balaclava helmet. In addition, I am having two pairs of sealskin gloves made, lined with puppy skin, which is the warmest you can have; these will have two thumbs so that when one side is wet, the other can be used. As regards footgear, I shall have two pairs of camiker, the outers being made of sealskin, the sole itself of the thickest type of skin, and the insides of the foot of dogskin, and the leg part of sealskin." *Letter from Croft. 'Sledge.' p.* 42.

"I had every article of clothing plainly marked with a strip of cloth in a distinguishing colour. . . . Since most of our garments were hung up to dry in the peak of the tent each night, and everything was of a standard pattern, the situation would have been impossible without this expedient."

Lindsay. Sledge. p. 79.

"*Personal (including clothes in wear) for man-hauling and packing, East Greenland, summer*, 1935: 1 double sleeping-bag; 1 rucksack; 1 ice axe; 1 pair climbing boots; 1 pair ski; 1 pair ski sticks; 1 pair ski skins; 3 pairs light wool socks; 2 pairs outer wool socks; 1 pair stockings; 1 pair short puttees; 2 pairs flannel trousers; 2 pairs wool pants; 2 wool vests; 2 shirts; 3 light Shetland sweaters; 1 pair windproofs; 1 pair snow goggles, orange and grey (Camp and Sports); 1 wool Balaclava helmet; 1 pair outer gloves (horsehide and canvas); 1 pair inner gloves (wool); 1 pair mittens; 1 knife; matches; 1 book; 1 wool mat; bromo." *Courtauld*. 88.208.

"I myself wore during the flight camel-hair underclothing and socks, fleece-lined socks, moose-skin moccasins, woollen breeches, squirrel-skin parka, reindeer-skin parka, chamois face mask, silk gloves, woollen gloves, dog-skin mittens, woollen cap, and snow goggles.

Hollick-Kenyon's outfit varied from this by an additional pair of socks, trousers instead of breeches. Canvas rubber-soled boots with insoles instead of moccasins, only one parka, an additional leather flying cap with earphones, and another pair of woollen gloves instead of silk."

Ellsworth. Antarctic. 89.207

MOUNTAIN CLOTHING

In the Himalaya up to 20,000 feet ordinary tweed clothes and thick, or better, layers of thin underclothing are worn, with a sheepskin coat (poshteen) for wear in camp at night. Shorts are often worn on snow. Above 20,000 feet the clothing is similar to Polar, with layers of thin light woollen underclothing and windproof outside. For the M.E.E. 1936 windproof suits for climbers were made of Grenfell cloth (Baxter Woodhouse and Taylor, Ltd., 17 Sackville Street, Manchester, 1), made up by Howard Flint, 48 Maddox Street, W.1: trousers tied at the ankle and *anorak* with fur at wrist and baby seal round hood. For the highest climbs eiderdown suits, consisting of padded double-breasted waistcoats and knickerbockers, were made by Robert Burns, Hanover Mill, Buxton Street, Manchester 1. This cubicell clothing was very warm, light, and expensive (ten guineas a suit), but delicate and soon fell to pieces; difficult to dry; good for sitting about in, but hardly worth while elsewhere than at extreme heights.

Remember that mountains have sometimes to be approached through low malarial valleys, requiring tropical clothing and precautions against mosquitoes, leeches, etc.

"Officers equipped themselves approximately to the following scale: 2 warm vests; 2 warm pants; 1 cotton pants; 3 pairs stockings; 6 pairs woollen socks; 1 pair puttees; 2 *puttoo* or tweed suits; 1 pair shorts; 1 pair grey flannel

trousers; 3 shirts; 1 sweater; 1 poshteen; 2 pairs gloves; 1 Balaclava cap; 1 woollen muffler; 1 pair climbing boots; 1 pair ammunition boots; 1 pair Gilgit boots; 3 pairs *chaplis* (leather socks and sandals); 1 pair slippers; 2 pairs pyjamas; 1 sun helmet; 12 handkerchiefs; 1 bath towel; 2 face towels; toilet requisites.

Two 12-bore shot guns and two ·375 Mannlicher-Schonauer rifles, with three hundred cartridges for the former and two hundred for the latter were taken; also one small collecting gun."

Mason. Shaksgam. Survey of India Report.

"All the clothing was made exclusively of silk and wool. For very cold weather suits of impregnated windproof material were used. The hats were designed to protect from the frost as well as from the sun, which was very intense, especially on the glaciers. Every member was equipped against cold and strong winds with a mask which fitted into a sort of aviator's cap under the hat." *Daszynski. Andes.* 84.216.

"The ideal protection against wind, for it is only with a wind that dry cold matters, is two windproof layers separated by a completely free air space and not merely extra windproof layers piled on in contact with one another. A hermetically impervious outer layer is scarcely possible and certainly not hygienic. Assuming, then, that the windproofing used reduces the air stream to 1 per cent., a double layer will simply reduce it something over ½ per cent., but allowing a free space to by-pass the leakage air stream a second windproof will have the effect of reducing the air movement to 1 per cent. of 1 per cent., or 0·01 per cent. This is a principle which, I believe, has been very little exploited by climbers. To arrange an entirely free intervening space all round is scarcely practicable in clothing, though it is done in certain arctic tents, but by inserting a layer of very porous material, such as extremely loosely woven wool, the principle nearly applies. With this idea I used two or three layers of wool as usual for bodily warmth, then a special windproof silk under-layer, followed by one or two layers of loose shetland wool under my outer windproofs. The result was extremely effective; I tried it with and without the silk underlayer. The latter in a wind was more effective than an extra sweater; in fact, I am almost sorry that the scheme was never put to a severe test." *C. R. Cooke. Kabru. Himalayan Journ.* 8.117.

Climbing equipment is outside the scope of this book: consult the Lonsdale Library volume on Mountaineering. Note only that M.E.E. 1936 obtained alpine rope and line from Arthur Beale, 194 Shaftesbury Avenue, W.C.2, and for roping on the final climb to the summit ivory silk parachute cord with breaking strain 800 lb. supplied by Irving Airchute of Great Britain, Ltd., Icknield Way, Letchworth, Herts. Hollow wooden snow pitons were supplied by Tucker Armoured Plywood Co., Crayford, Kent. Smythe on Mount Kamet used aluminium pitons which served also as tent pegs.

Austrian climbing equipment, ice-axes, crampons, etc., made by

Horeschowsky, Vienna, can be obtained through Robert Lawrie, 38 Bryanston Street, W.1.

"During the journey we used ice-axes as sledge-anchors, anvils, and clothes-horses, but never for what they were intended."

Lindsay. 'Sledge.' p. 247.

CLOTHING FOR FLYING IN THE ANTARCTIC

On no account wear fur or skin clothing except for gloves and boots. Should a forced landing be made fur is very heavy and bulky for walking; will collect snow which cannot be brushed out easily but will thaw, and wet the whole garment, adding weight; and it will be impossible to dry it in a tent. Directly the garment is removed it will freeze solid.

Windproof suits overcome all these difficulties: snow can be brushed or shaken off with ease; a few minutes over the primus in the tent will dry them; they are extremely light. Wool is as warm as fur and much lighter, and when walking you can adjust the number of garments worn to the temperature.

In winter wear woollen underwear with long sleeves and legs; flannel shirt; blanket trousers with tapered legs to fit closely round the ankle and zip fasteners to allow the foot easy entrance; woollen sweaters according to temperature (the inner sweaters should not have roll necks, only the outer); blanket coat of Mackinaw cloth. Over all a windproof suit with close-fitting hood, and trousers with thigh pockets; Balaclava wool helmet under the hood (earphones can easily be attached to the helmet); two or three pairs of woollen socks; one or two pairs of blanket shoes (Hudson's Bay Co. duffle); deerskin moccasins; gloves; woollen inner mitts; fur or leather outer gauntlets.

I found it most comfortable and warmer to wear artificial silk underwear underneath the woollen. Also that the Air Force pattern of silk finger gloves, with three layers of silk, should be worn under the wool mitts. The hands do not then get cold when writing or doing things in the air and on the ground where fingers are necessary.

Wear coloured goggles when flying over snow; on overcast days they definitely improve the vision. Salvoc yellow goggles by Theodore Hamblin, Ltd., of Wigmore Street. Carry a face mask in case it is necessary to open the windscreen or to look round it owing to frosting.

In summer wear similar clothing of less thickness and number. Wear sealskin boots in place of mocassins; they are watertight and reach up to the knee to keep the legs dry in wet snow. Coloured goggles are not essential if flying over water in the summer, but useful if flying into the sun, which is never very high in polar latitudes. *J. R. Rymill.*

DESERT CLOTHING

In heat suggest aertex or khaki shirt with slacks or shorts; but shorts are not considered decent in Arab countries. Turban often better than sun helmet: protects from cold as well as heat. Sheepskin coat for night.

"My nose and lips were already raw from the last few days' sun, and one now fully appreciated the ample folds of the Arab head-dress for its protection by day and its warmth against the cold nights."

Thomas. Rub' al Khali. 77.23.

Women may find slacks cooler and more comfortable than jodhpurs, with light riding skirt or long dust-coat for towns. Felt hat or beret or scarf according to time of day.

"I wear ordinary woman's dress and find that modesty as to long sleeves, high neck, or skirt are all commented on and appreciated by the ladies among whom I stay. The skirt should be pleated almost like a kilt for convenience in sitting on the floor. It is important to be able to cover up one's feet when sitting cross-legged, as it is insulting to exhibit the sole of the foot and very fatiguing not to do so: a wrap kept near at hand to throw over one's legs is very useful. I wear breeches under the skirt for riding: a tunic with pockets and zip fastener, so that one can open the neck—though as a rule one requires all the protection possible against the sun. I found for instance that I got so burned through my light stockings, I was forced to adopt woollen ones in the hot weather. A coat must always be close at hand at sunset, for the sudden drop in temperature. A double terai is sufficient headgear except in dust-storms, when an Arab *keffiya* which can cover the mouth and protect the eyes is better: but a sunshade is better than a hat, since it makes a cool space of shadow for head and shoulders: it was found so useful that my guides would always borrow it when I was not using it myself! Footgear must vary with the country; unless it is too stony or too thorny, light shoes are pleasantest, and I found the Persian cotton *givas* very comfortable." *Freya Stark.*

Clothing as always depends on seasons and fashions. Man is most comfortable in the clothes he is used to. Native clothes are unsuitable for cars, being liable to catch in the machinery, but it may be necessary to bow to local customs. Shorts and a bush shirt, and sandals without hosiery are most practical. For cold weather and chilly evenings, stockings, a pair of flannel trousers, a woolly, a Balaclava helmet, and a scarf should be taken. Gloves may also be wanted for driving in the early morning. The most suitable head-gear is a single Terai with some means of hitching up the sides to stop flapping in a wind. The ordinary Bombay Bowler type of topee is a good substitute. *R. A. Bagnold.*

"For clothing I decided to wear the Arab *gibbah*, or shirt, the *immat*, or turban, over bush shirt and shorts. My legs were bare, my feet in sandals of a type similar to those used by members of Bagnold's last expedition in 1932,

a specimen of which I obtained from Prendergast in Khartoum and had copied locally. There were two main considerations affecting the choice of clothing for use in the sand sea; protection from the sun and protection from the cold. The first was obtained by the means I employed, but the second was very inadequately provided, and cold proved to be one of my principal hardships." *Orde Wingate. Libyan Desert.* 83.287.

"In Sinkiang sheep skins, warm fur caps, wadded quilts, coats, and trousers are good, cheap, and efficient. Locally woven cotton cloth is rough, but of fair quality, and makes serviceable shirts. No woollen cloth obtainable anywhere. Always wear breeches, not shorts, made of Khaki drill. Rain is very heavy in the mountains, and waterproofs for all are essential, with ground-sheets and a few tarpaulins. The traveller requires one decent suit for visiting; an ordinary tweed will do.

Long boots of stiff leather are cheap and useful. They keep out the dust, but are useless for walking: nobody walks in Central Asia. A sort of over-sock or felt stocking is worn with these boots which should be roomy."

Schomberg.

Whipcord or Bedford cord breeches for ordinary winter wear; Kalgan leather for extreme cold. Khaki or gabardine breeches for ordinary summer wear; shorts for tropical heat. Grey flannel trousers to change into in camp. Any old coat. Plenty of woollen pullovers or cardigan jackets. A leather waistcoat for winter winds. The cold in winter on the Mongolian plateau may be severe, down to twenty and more below zero Fahrenheit. Fur robes and sleeping-bags of sheep-skin are essential and can be made up at the Chinese border towns.

A fur and leather flying cap is as good or better than any other form of head-gear for resisting cold winds. In High Asia in winter do not forget grease for the face and goggles for the eyes; and a good warm scarf for the neck.

Siberian leather boots lined with lambskin are the best for extreme cold; or Turki leather boots lined with felt. For use in camp, Gilgit or Mongolian felt boots; but one cannot march well in them and they are not as good as lined leather boots for snow and for crossing freezing streams.

Take one respectable suit for use when meeting and being entertained by officials and missionaries in the interior. *E. Teichman.*

TROPICAL CLOTHING

Distinguish between tropical climates with two wet and two drier seasons and equatorial climates such as the low part of the Congo Forest, Brazil, or Guiana with tree canopy and no dry season.

First decide whether to attempt to keep dry in heavy rain, or be content to get wet through and change into dry clothes at end of day.

Efficient protection usually impossibly hot: hence second generally preferred.

Next consider whether mosquitoes, ticks, leeches, etc., forbid exposure on the march, and demand ampler protection in camp during evening. Usually avoid shorts, and prefer knickerbockers closed below knee, and stockings. Try silk stockings (as knitted in Chefoo) under woollen.

Consider also protection against sun, and personal resistance to heat, sunburn, etc.; also liability to chill, and whether the often-derided cholera-belt essential. If so, see that it is right and fits so that it does not ruck up: silk and wool a good material.

Choose underclothing which does not cling.

Clothing must not be too thin or sudden heat will cause excessive exhaustion, but remember that on the Equator above 6000 feet it can be cold at night. Khaki shorts comfortable and cool but bad where mosquitoes exist. Khaki trousers awkward in wet grass. For general use breeches of stout khaki or light Bedford cord. Khaki shirt with two breast pockets and flaps; khaki-coloured flannel for high land, cotton for coast. Slacks for camp wear, sweaters for night; pyjamas of light flannel or cotton according to altitude.

Felt helmets are better than pith, which do not stand rough wear. Wolsey pattern is good, protects the neck, but is unsuited for stalking. Double Terai hats are good, and soft felt hats with good brims essential for camp.

Remember that boots must not fit tightly because in heat the feet tend to swell on march. Nailed boots good in rough country but the points liable to wear through. On long journeys carry an iron boot-maker's last. Take grass seed off puttees, roll them up, and place one inside each boot at night to avoid entry of centipedes, scorpions, or snakes.

Carry a roll containing thread, cotton, buttons, various needles, wool for repair of socks. *C. W. Hobley.*

Take all usual tropical health precautions. Take every opportunity to dry clothes. In prolonged wet weather it is better to dry them directly over a fire, despite the smoke, than to live constantly wet. Avoid throwing bedclothes off the middle of the body at night. A rubber and cork (not sola) topee withstands rain much better than a double terai, and is protection against the sun in clearings. In the forest a hat is unnecessary unless it is raining. Shorts and a vest are comfort-

able, but useless if mosquitoes or leeches are about. Against mosquitoes wear long trousers and shirts with long sleeves. Against leeches wear thin breeches cut like plus-fours, stockings, boots with the tongues sewn in all the way up, and puttees. This mechanical protection, though not complete, is much better than any chemical (*e.g.* soap or tobacco), which wash off the first time one gets the legs wet. Leeches never ascend higher than the knee, and one may wear a sleeveless vest unless there are also mosquitoes. A strong umbrella is valuable. Some knapsacks should be double material and really waterproof.

One is commonly told that natives carry 50 lb. as a matter of course, but actually it is very difficult to get carriers in hot damp climates if the loads exceed 30 lb. *J. R. Baker.*

Wear pyjama-trousers or shorts, stockings with silk socks underneath, a vest and shirt, solar cloth jacket, hard cork topee (buy in India) which protects head from blows and keeps light in wet weather; nail boots with tongue sewn in; dark glasses; washleather gloves; butterfly net over topee. Mackintoshes pick up leeches.

F. Kingdon Ward.

CHAPTER VII. BAGGAGE

BOXES AND BASKETS

For sledging plan very light three-ply boxes with light battens on edges and bottom to fit the pemmican boxes and the sledge, one box to contain 35 to 40 lb. of food.

For horse-transport carry stores and spare clothing best in yakdans, which are boxes covered with leather and padlocked, bought in pairs, one with two hooks the other with two chains. Sling in pairs over the animal with roll of bedding on top and tarpaulin over all. Same for camels.

For camels long thin trunks of cane covered with leather are good, and last better than wooden boxes such as are sold at Aden.

Kiltas are circular baskets covered with leather, the lid with a hasp, bought in Simla, Kulu, and Kashmir. They do not load so easily on an animal, but are more comfortable on a porter, and lighter. One yakdan is a light coolie load.

Willesden canvas outer cases lined with Sorbo rubber are excellent for carrying instruments and anything fragile.

Each package must have a serial number, but not necessarily consecutive: *e.g.* begin one principal series at 101, next at 201, and so on. If coloured bands used also for easy identification, see that system is chosen intelligently, colours of good quality and unfadeable; that bands not painted just where tie-ropes rub them off, and that the transport officer is not colour-blind. (See 'Everest 1933,' p. 282.)

For all work choose carefully the shape of box or package. No general rule can be made, but on the whole the perfect cube is the worst shape, except perhaps the barrel without rings or handles. For food boxes on camel or car journeys, I have found three-ply boxes with screwed battens and end ribs are best; for camel loading, boxes $30 \times 10 \times 8$ inches are excellent. Tying two small boxes together for one side load is bad; they always come undone. Three-ply is good while it lasts, but it succumbs to rough treatment and then is difficult to mend without an adequate set of carpenter's tools, screws and glue, without which no expedition is complete. Iron trunks are good for instruments both on camels and motor cars, again if they are long rather than square and not too heavy. Get the best quality iron trunks only with internal strengthening battens, two locks, bolts as well and a handle at each end; and don't forget on a long trip to take a soldering

outfit to mend the boxes when they split along the sides and seams. Remember that everything falls off every camel sooner or later. Therefore instruments must be packed in cases either wrapped up in clothes or, better still, in cases lined with 1½-inch sponge rubber covered with baize. Even when the traveller has got his rubber-lined boxes, he should still pack the more delicate instruments in them wrapped up in shirts and clothing. I have never had an instrument broken or damaged in transit even by severe falls of cases from camels on to rock. I have broken instruments, and seen them broken, by careless handling, but never in transit by dropping when carefully packed. Rubber-lined instrument boxes are also advisable for motor car and porter work. It is well to paint instrument etc. boxes for camel transport in such a way that the same pair of boxes are loaded together on the same camel. On my last expedition I had six iron boxes, two for wireless equipment, two for instruments, and two for stores, maps, books, paper, and similar stuff. The boxes were painted with red, blue, and white squares on the top, front and ends, so that each two reds, blues, and whites went together. The system is better than numbering the boxes as the native personnel can recognize the cases and load or leave according to directions. Such markings also help the European traveller himself on a dark night or when he is in a hurry or cannot find the right key. The ideal arrangement for instruments on all expeditions is that, however few in number and however primitive are the sets carried, two of each or at least two of everything that can possibly be broken should be taken. And in each case of duplication one instrument or part should be in one box and the other in another box on another camel. The arrangement also helps to divide expeditions readily into parties.

Very delicate instruments like half-chronometer watches should preferably not be carried on the person. They are less shaken when carried in special pouches or boxes, since the wearer invariably runs about more than his motor car or camel or other means of locomotion. For camel work, watches, barometers, and other delicate things, should be packed each in a separate box and the collection of boxes placed in a container to suit the traveller's requirements and equipment. I carried my half-chronometers in leather velvet-lined stud boxes and in box-wood boxes lined with cotton wool, all of them so shaped or marked that one could readily tell which way up the watch and its box were. These boxes I carried packed in a leather pouch so that they could not rattle or bump under my riding saddle, and always under my own attention. Watches and instruments which are very sensitive to high temperature changes should not be carried in iron boxes. Jumping on and off a camel or other animal mount, or off the seat of a motor car

is fatal for watches; they are much happier in the constant state of moderate unrest of motor car or camel on the march than subjected to feats of personal athletics. Shooting expeditions of an evening from camp over rock are peculiarly bad for watches; if you must carry them on the person, leave them behind before going out.

In very hot weather iron boxes standing in the sun get very hot. If they are not covered with mats or tarpaulins or left standing with the lids opened, the temperature inside of boxes rises to 140° F. or more. Remember that this is well above the temperature of clinical thermometers which, if packed in medicine chests and so transported are infallibly broken from this cause. I speak only of clinical thermometers because no one would be foolish enough to go to a tropical desert with meteorological or other scientific thermometers unprovided with a safety chamber or with so small an upper range as to endanger bursting at 140° F. Certain stores carried in iron boxes may also suffer considerably under great heat, *e.g.* some coated medicines, certain drugs, waxes, candles (even "tropical candles") "solid" alcohol fuel, the fluid of fluid compasses, etc., unless there is an air bubble to provide for expansion. When great dryness is added thereto, book bindings, leather equipment unless continuously greased or oiled, grass and palm rope unless constantly wetted, spider thread graticules, resinous or glue settings of lenses, fibre, guttapercha, indiarubber, the insulation of electric leads, etc., are all apt to suffer. Curiously enough, raw hide does not seem to suffer, but skins which have been wet and have dried must be very carefully softened in water before again being used to prevent cracking at the edges and creases. *Francis Rodd.*

"Ration boxes for the Northeast Land expedition 1935–36 were $20 \times 11\frac{1}{4} \times 8$ inches deep, outside dimensions. Size governed by dog pemmican tins $5\frac{1}{8} \times 3\frac{5}{8} \times 1\frac{1}{2}$ inches deep, which packed into box in two layers of two rows of 12 each on edge: 48 tins." *Andrew Croft.*

"Extra light sledge boxes (Luralda three-ply) were made which were just sufficiently strong for the journey. This saved considerable weight. Each box held two men's food for ten days. A second box was taken for each tent to hold cooking gear, tent, rope, etc. A further box held the instruments, medical supplies, and so on." *A. Courtauld. East Greenland.* 88.207.

Dimensions: Outer $19\frac{3}{4} \times 13 \times 9\frac{3}{4}$ inches deep
Inner $18 \times 12\frac{1}{4} \times 8\frac{1}{2}$,, ,,
with two battens 15 inches apart nailed to bottom.

"Part of the food was taken out from England already packed in boxes of a size and weight suitable for the horses (as advised by Herr Grape). For this purpose we obtained from Messrs. Lyle some of their wooden boxes used for 'Golden Syrup' tins which were recommended to us by Dr. K. S. Sandford from his Egyptian experience. These boxes measure 30 inches by 40 inches by 9 inches, and when fitted with hinges and catches, are ideal for the purpose. Two can be slung on each horse." *O.U.E.C.* 3. *Lapland.*

"Each of these methods of transport is very rough on the loads. The best loads would be packed in boxes and would weigh about 60 lb. The 'Venesta' are to be recommended, especially for stationery and minutiae. Rucksacks were not good; not only the contents, but usually also the rucksack itself became broken. This style of packing also offers too much temptation to mule-drivers to search and to rob. It might have been thought that boxes were an awkward form of packing in very mountainous country. But this is not the case. A Mount Everest porter makes up such a load with his own property into a cumbrous parcel which he carried by means of a head band. It is convenient if loads can be broken down into smaller units than the above-mentioned 60 lb., though 60 lb. is a load which could be carried by a porter on a main transport line between camps." *Spender. M.E.E.* 1935. 88.297.

"For carrying kit buy the Peshawar yakdan, not the Kashmiri type; if long, but not high, they make a good load. Buy also a large number of thick, strong, coarse sacks made in Turkistan, to carry bedding, camp kit, and some boxes. These sacks last long, and protect contents from dirt, dust, sweat, damage, loss, and pilfering." *R. Schomberg.*

"For Africa clothing in light steel uniform cases, maximum size $31 \times 13 \times 9$ inches deep; several good makes are practically water tight; if to be carried as a head load, a wood bottom is good.

Food in strong but light boxes of plywood with battens at the edges, and each secured by a brass padlock: all opened by the same key. Maximum size $29 \times 13 \times 11$ inches deep." *C. W. Hobley.*

"We treated our chronometer with the utmost care. The box in which it was contained was put into a packing-case filled with shavings which were kept continually stirred up and which acted as a cushion to absorb any impact. Owing to the uneven nature of the road the chronometer had been swung on its gimbals throughout the journey, while the packing-case in which it was stowed was given an honoured place in the most comfortable portion of the lorry." *Clifford. Kalahari.* 75.25.

"That the two aneroids gave such satisfactory readings in spite of the jolting inseparable from sledging is due in a large measure to the fact that their case was lined with Sorbo rubber ½ inch thick, and that the inside of the instrument box was also lined in a similar manner." *Lindsay. Greenland.* 85.405.

BAGS AND SADDLE-BAGS

Clothes are best carried in canvas kit bags, cylindrical. M.E.E. 1936 supplied with heavy green rotproof canvas kit bags, waterproof inner lining and shoulder straps, 3 feet 2 inches by 2 feet 4 inches, by Silver and Edgington, Ltd., 69 Great Queen St., Kingsway, W.C.2.

Carry saddle-bags whenever possible for immediate necessities: films, notebooks, field-glasses, lunch, thermos, butterfly-net, portfolio for plants. Useful emergency saddle-bags can be made of gunny bags.

Bags are necessary for sheep transport, made of canvas as in Leh. Food for coolies should be carried in sealed bags with very small mesh to avoid pilfering by opening the mesh.

Nets for holding small and irregular packages are found in local varieties.

For camels and motor cars, avoid especially a lot of small pieces or loose objects; they tend to get lost, and, if used to produce a Christmas tree effect on a camel, probably fall off or bump and make a noise which will frighten the animal with disastrous results. A camel stampede is very frightening and usually dangerous. Most camels do not mind shooting; one can usually get or train one to stand while the rider shoots from his back—but a rattling tin can is bad for his nerves. If the traveller has to have a lot of small objects they are best loaded in a rope net, or stowed in a large packing-case for motor transport.

Francis Rodd.

RUCKSACKS AND PACKS

Some prefer the simple rucksack without pockets, big at the bottom, with a flat floor and extension straps on flat buckles. M.E.E. obtained ordinary rucksacks from Camp and Sports Cooperative, Ltd., 21 Newgate Street, E.C.1, and lightweight rucksacks from Robert Burns, Hanover Mill, Buxton Street, Manchester, 1. But Everest pattern carriers essential if tent and sleeping-bag carried.

A wide range of rucksacks and carrying frames made by A/S Bergans, 7 Ovre Slotts Gate, Oslo.

Mr. W. T. Kirkpatrick made a light-weight rucksack by attaching a mackintosh waterproof bag to a pair of ordinary webbing braces. It had two or three loofahs for ventilation between the rucksack and the back instead of a frame.

"Each man carried a Bergans rucksack (net weight 4 lb.), containing from 16 to 25 lb. of kit, apparatus, etc. The usual weight of stuff carried on the earlier parts of the journey varied from 25 to 35 lb., since at times it was necessary to shoulder all or part of the sleeping kit. It was found on the whole that 30–35 lb. packs (even after hard training and on good rations) were impracticable for the type of trekking which we undertook. That is to say, it was perfectly practicable to carry that amount, but not to combine movement with scientific observations *en route*, since the extremely rough ground forming the trail necessitated nearly full attention on the business of walking. During the trek from Kautokeino to the Reisen Valley, we carried 20–25 lb. only, and noticed the greatly increased power of observation which resulted." *O.U.E.C.*3. *Lapland.*

WATER TANKS have been treated in Chapter V, pp. 55, 56.

CARRYING FRAMES

A carrying frame is generally required for miscellaneous porterage, instrument boxes, and sacks. The Mount Everest carrier, which is an improved Bergans rucksack frame, is a steel frame and shelf with straps made by Camp and Sports Coop., Ltd. A basket frame, more comfortable in the Greenland summer, cannot stand up to the heavy loads one must often carry.

Natives who are conservative generally prefer their native carrying frames.

"The Asumbos customarily carry loads upon their backs lashed into long wicker-work cradles suspended from the shoulders and tied around the waist."
Sanderson. Cameroons. 85.119.

CHAPTER VIII. PREPARATION ON ARRIVAL

Preparation and preliminary studies at home have been dealt with in Chapter II. A further series begins on disembarkation and arrival in the country which is the base of operations. One will call upon the British representative and enlist his advice and help in the necessary visits of ceremony to local authorities, discover any special points in getting stores and gear through the Customs, or local requirements for permission to travel inland; the latest news of political and economic conditions in the field, and news of any other travellers in that field. Give the British official some idea of plans, the name of the expedition's representative at home, and how far the expedition expects to remain in touch so that he may judge how far no news is good or bad. Inquire upon local agents for transport, the means of obtaining personal servants, the arrangements for posts and communications, the methods of obtaining currency or credit, the purchase of local supplies for the caravan, rates of pay, rations, and presents, the engagement of guides and interpreters, and a thousand other things according to circumstances: a few of which may be suggested by the following notes.

"Travel in the Hadhramaut is very easy, for the main routes are so well organized that there is little more difficulty in planning a journey through one of the brokers of the Badawin than there is in planning a journey through Europe with the aid of Thomas Cook's. As we were to travel *via* the wadi Du'an our caravan belonged to the Seiban tribe and were members of the Rashidi clan. Arrangements were made for us by their broker, one Ba Ubeid, a cheerful smiling person whom we liked very much." *Ingrams.* 88.529.

"In Persia the only drawback to travelling as a woman is the national dislike of taking orders from our sex. I have never found this in Arabia. In both countries one is always well treated if one remembers to be a 'guest'; to travel without escort or servants—*i.e.* entirely dependent on the hospitality of your hosts, is far the safest way of getting through difficult country. Both in Persia and Arabia any pursuit of learning is respected provided it is of a kind which they understand. And both nations are lovers of their own language—so that it is a great advantage to talk *good* Arabic or Persian rather than the colloquial: even if they do not understand it. They respect their classical language." *Freya Stark.*

TREATING WITH LOCAL OFFICIALS

It is of the first importance to obtain the best advice on the etiquette of dealing with local authorities, in which modern travellers are

sometimes negligent. Discover whether it is expected that the leader of the expedition should write in advance to the authorities of the next province; whether it is the custom to camp outside a town or village, send forward a messenger with a letter or card, and await the arrival of some one coming out to meet the party; how to arrange the party in the proper ceremonial order for entry into the town; what are the phrases or greeting and the ceremonial of receiving gifts, such as the white scarf in Tibet; what is the etiquette of calling upon the authorities, and especially how to take formal leave.

Success in China depends upon a man having the attitude that he is the guest of the Chinese. In ordinary talk with an old-fashioned official it is usual to ask a formal set of questions and show interest when introduced to a new man. But among modern officials who are satisfied with your credentials, the tendency is to get down to business.

Presents have been dealt with already in Chapter II. Remember that overdoing presents may produce the impression that you are playing for more important ends than you profess, and that to a Chinese to save face in front of subordinates is more significant than the value of any gift he may receive, while a traveller may lose face himself by being kept waiting in the wrong place: hence the importance of knowing local etiquette.

CURRENCY

In Central Asia the Indian merchants will generally cash cheques, which circulate and may not be presented for a long time, so that record of such cheques must be kept carefully, and the necessary arrangements made with the bank on which they are drawn. Alternatively a merchant in a large centre will often arrange for his agents or correspondents in distant towns to advance money as required.

"In many districts paper money is of no use: one requires a great quantity of silver, which makes a heavy and conspicuous bundle. I usually divide mine into two, and keep one hidden in my saddle bag and entrust the other to my guide. A store of gold can be sewn round the waist in a belt, and notes can be kept between the two felts of a double terai where no one thinks of looking. Poverty is a great safety in lawless regions: it is often not advisable to show that one has paper money at all." *Anon.*

"In Central Asia money is a difficulty; unless suitable arrangements are made a loss of 20/30 per cent. on each transaction is not unusual."
R. Schomberg.

In China standard silver currency and notes of the Bank of China are increasingly accepted everywhere without discount, and cheques are generally accepted by local merchants if you are introduced by a missionary. In Chinese controlled territory generally one may arrange for branches of the Chinese Post Office to cash cheques on Shanghai. And similar arrangements may be made in many parts of the world.

"We were still nominally in China, but the only sign of Chinese influence was a large stone which the Mongol brought with him to ring our silver dollars on in order to be sure whether they were good or not. Luckily they were." *Fleming.* 88.138.

"We also inspected the 'mint,' and were interested to hear that no less than 30,000 banknotes a day are produced without a penny of capital behind them." *Fleming. Khotan.* 88.141.

But the principal difficulty on the march in Asia and in Africa is to carry enough currency to pay for transport: coin is required, for notes are usually not accepted. A large expedition may carry its money in a treasure chest under guard; others may distribute it in the personal baggage and handle it only at night, one of the party carrying enough loose cash for daily small expenses. A traveller in China advises carrying dollars in tin canisters made to hold fifty, to avoid the chink of money bags.

"The supply of small cash upon expeditions is a matter normally neglected by travel writers and even, I am told, by travellers in the field, on some occasions. In our case it presented an almost insurmountable obstacle. For days or even weeks before we moved our quarters, messengers had to be sent to native courts, traders, chiefs, and similar influential institutions sometimes at considerable distances, to beg for pennies or shillings. Both are essential, as even natives used to European enterprise refer to paper notes as 'books' and refuse to accept them, believing them to have no more intrinsic value than an I.O.U. from a white man; which, unfortunately for our prestige, is not always quite as reliable as is popularly supposed. Carriers are paid in pennies, occasionally in shillings, food is bought with pennies and all our specimens were purchased at rates varying by pence or fractions of pence." *Sanderson. Cameroons.* 85.121.

Payment in kind requires local knowledge and much transport, except in specially controlled territory such as Greenland, where Danish currency is not valid, but a letter of credit on Copenhagen providing credit with the Grønland Styrelse allows the traveller to draw goods from any of their stores and to take passages on any of their ships, so that little money is necessary, and employees are generally paid in goods.

"The Gainyamya afterwards visited Menyamya with food—which was purchased with trade knives, etc.—and remained friendly for the rest of the period. The Karakaiya proved to be the most primitive natives they had met, for they resolutely refused to accept any knives, axes, or steel goods. Mother-of-pearl shells and ordinary shells however won their approval and eventually paved the way for peace."

Chinnery. Central New Guinea. 84.404, 5.

Remember that in many countries *dastur* or *squeeze* is the percentage a servant will take on any transaction passing through his hands: a regular well-understood practice which must be allowed.

LANGUAGES

Good travellers will have learned before starting something of the widely spoken languages, *e.g.* Arabic, Turki, Persian, Urdu, Swahili, at the School of Oriental Studies in London. During the voyage out continue this study, and arrange to have time on arrival for further lessons in local dialect and practice conversation with the personal staff as they are engaged.

"For me one of the most interesting of surprises in Turkistan was to discover the great extent to which Persian is used as the language of everyday speech. This is all the more surprising to any one who has been in Persian Azerbaijan where, even in Tabriz, it is common to meet a man who only speaks Turki, and where half the people who speak Persian admix it strongly with Turki words and accents. Never in the bazaars of Mazar-i-Sharif did I find my own hideously ungrammatical rendering of Persian incomprehensible, nor did I ever find much difficulty in understanding. . . . I have it on the authority of the Vice-Consul of the U.S.S.R. in Mazar-i-Sharif that Persian is, though to a lesser extent perhaps, a common speech in the bazaars of Bukhara and even Samarqand. When it is considered that Baghdad and (presumably) Najaf and Karbala are virtually Persian-speaking towns, it is seen that a trader might pass thus from one extreme limit to the other of the Sassanid Empire and beyond, knowing only this one great language."

Christopher Sykes. 84.333.

"I must join issue with Major Cheesman, who has stated that 'the Badawin language is very different from Arabic, and I had much difficulty in understanding it.' He was referring to the Murra tribe. . . . In all my experience of the Murra I never heard them speak any language but Arabic, whether they spoke to me or to my non-Murra companions or among themselves, while the Arabic they spoke was of that pure and beautiful kind which one is tempted to call classical. . . . The difficulty of understanding the speech of such people arises more from the fact that in the realm of thought they are poles apart from the so-called civilized man who speaks in prose while the Badawin spout poetry without self-consciousness. If you call to a man he will not reply 'What?' but 'May you rejoice,' or 'Here am I.' "

Philby. Rub' al Khali. 81.8.

Every effort must be made to master the elements of a few languages widely understood, and to practice the art of expressing oneself in simple, direct, and concrete language, with ingenuity in making what you can say serve for what you want to say.

"There are however occasions when it is vitally necessary that some member of the expedition should be able to speak to the men in their own language: this is a very different thing from the smattering of Hindustani which most keen members sooner or later acquire. Moreover the effect is never the same when conversation has to take place through the medium of an interpreter. The men themselves feel very strongly on this point, and will work much better when they know that if necessary they can make a direct appeal to some member of the party." *Morris. M.E.E.* 1936. 89.502.

Interpreters are a necessary evil, and double interpretation unreliable except for the simplest needs. One member of the party must know enough of the language to keep some check on the interpretation.

PERSONAL STAFF

There will usually be some permanent native staff and servants engaged for the whole journey, and a larger number of caravan men and coolies changed at intervals. Remember the importance of medical examination before engagement. When a native cook has been selected, make him cook awhile for you before you move off. See that he has lessons in making bread, but do not expect too high a standard of cleanliness.

"Good servants or even bad ones do not exist in Turkistan. It is better to take too many than too few, as none can be picked up. All should be Muhammadans and preferably talk Turki. Good men can often be found in Leh. The average Kashmiri not much use: rarely a born commander outside his own country; but he can cook, which no native of Sinkiang can do. The cook is the only man who really matters in the caravan." *R. Schomberg.*

"The party has consisted of our two selves; two, or the first season three, trained Kufti workmen from the Nile Valley to act as exemplars to local labour; camel men; and for the rest we have recruited Kharga villagers, varying in numbers from two to thirty-five in accordance with the needs of the work. We avoid that pestilence of Egypt, the *rais* or headman, and keep the organization and questions of discipline and direction in our own hands. We have found the raw locals, unfamiliar with the kind of work required of them, industrious, fairly intelligent, and obedient, and definitely superior to the equivalent fellahin class in the Nile Valley."

Caton-Thompson. Kharga. 80.370.

"During the first day's march the guide took up a position in the rear of the party, and on my asking him if he did not consider that the right place for

the guide was in the van, he replied that the matter was immaterial, as up to the next village there was a well-defined track, and beyond that the way was quite unknown to him." *Humphreys. Ruwenzori.* 82.496.

"I managed to get two Kayans who said they knew the way across. The first day, after travelling hard for six hours, we were surprised and excited to come upon footmarks which the Kayans declared to be those of nomadic Punans who roam this area; closer investigation showed the footmarks to be our own, and proved that we had made a complete circle."

Harrisson. Sarawak. 82.397.

"Some natives, usually the most stupid ones, delight in hoaxing a stranger and giving him information of a deliberately misleading character. This is a harmless form of amusement that it is best to encourage. It is very easy to detect. Merely plotting the data will often betray its unreliable character, and if any doubt exists on the point, it is only necessary to get an informant of this type to repeat the information after a lapse of a few days, under pretence of having forgotten it, and if he has invented the route described he will by that time have forgotten what he said and retail an entirely different version. To let a native of this type see that his fraud has been detected will almost certainly stop him from imparting any further knowledge and make him pretend ignorance when questioned. On the other hand if he is allowed to ramble on he will often let out intelligence of considerable value on the assumption that his victim already knows it." *Harding King. Libyan Desert.* 77.547.

"The European is always given the headman's room and food, and he is treated as a respected friend, a 'superior equal,' by the native; he enjoys a position which must be unique, for there is no trouble about prestige or colour bar; the white man is expected to join in every sort of native activity, to drink with them, to join in all ceremonies, and so on. The more native bangles and tattoo marks he has the better. If he can charleston or do conjuring tricks he is bound to be a success." *Harrisson. Sarawak.* 82.388.

The variety of national characteristic is best illustrated from extracts from the papers by different travellers which follow. One cannot generalize when people who are near neighbours have such different characteristics: it is said for example that one should treat the Kashmiri as a servant, the Balti as a child, the Hunza man as an equal, the Sherpa Bhotia and Gurkha as a comrade, but not too familiarly: that an Eskimo believes you are helpless in his country and does all in his power to make the journey a success, so that an Eskimo can be treated as an equal, and he is pleased; but that an Asiatic may expect that you shall occasionally display superiority: the last proposition doubtful.

In southeastern and eastern Tibet, except on the main trade-routes, transport is often limited, and too large a party will frequently be held up, or forced to move in relays, with great loss of time. Best size is

2 Europeans with a minimum of 3 native servants for permanent staff. If the journey is planned for a year or more, and for serious work, this means 40 to 60 coolie loads of baggage (20 to 30 yaks or ponies), generally obtainable.

Two Europeans with less than 3 servants will be looked upon as people of no importance, and there will be difficulty in obtaining transport or labour at less than exorbitant rates. Since native servants need not be allowed more than 1 coolie-load (60 lb.) of personal baggage apiece, 5 or 6 can easily be taken without appreciable loss of mobility, and with considerable increase in prestige. Remember however that Tibetan servants are generally lazy, while Sherpas thrive on plenty of work and quickly become disgruntled if they have not enough to do; so that, if there is any probability of there being more servants than jobs, it is wiser to take Tibetans. In a feudal country like Tibet it is well worth paying for 2 or 3 more servants than are strictly necessary, if by so doing one's apparent status is raised: the higher the rank the fewer the difficulties; which will be further diminished if the traveller has sufficient knowledge of Tibetan etiquette to acquit himself creditably with the officials he will meet.

Although there is a different dialect in almost every district, Lhasa Tibetan is the *lingua franca* of trade, and is understood, more or less, everywhere. With Tibetan-speaking servants therefore (such as one would naturally choose for such a journey), who speak the Lhasa dialect and some form of Hindustani, there is no need to have special interpreters anywhere. But know enough Tibetan oneself to understand what is being said when enquiries are made, for a servant may give a false report to suit his own convenience. *R. Kaulback.*

"At the start of our journey we were accompanied by seven Greenlanders, thus making a party of ten men with nine sledges and eighty-six dogs. The natives worked well at first, but after the fifth day three of them insisted upon going home, and even the offer of double wages was no inducement to them to stay. This was a great blow to us, more especially as the others began to lose their enthusiasm. . . . We had a rough journey over the frozen pack-ice, but reached Eke safely. From there it was a steady uphill grind over mountains and frozen lakes; and again it was a race not only with diminishing dog-food but also with the homing instincts of the Greenlanders, who daily threatened to leave us." *Lindsay. Greenland.* 85.397.

"The Badus are attractive companions despite their religious frenzy. If they pray punctiliously and have frequent outbursts of religious piety, there is nothing mealy-mouthed about them. They are realists. They shed the blood of their enemies without the flicker of an eyelid, and camels plundered in the raid give no qualms of conscience, for they are the spoils of war and not ordinary theft; but between friends there is a fine spirit of comradeship. . . . He sets great store by manly qualities—valiance in war, skill in riding and

shooting, and the exercise of resigned patience when faced by hunger and thirst. He is a cheerful companion." *Thomas. Rubʿ al Khali.* 78.217, 18.

It will be seen from what follows that many native races, especially Africans, have remarkable aptitude as assistants in scientific work.

"I should like to include under the title of personnel at least the five literate African boys whom we trained as taxidermists, collectors, and scientific assistants. When they came to us their only qualifications were the broad grin of the West African, some desire to work, a certain knowledge of writing, and, to a very limited extent, spelling. By the end of the expedition they were expert taxidermists and collectors, well versed in the use of alcoholometers, hygrometers, and other instruments presenting equally insurmountable difficulties to their untrained minds; but they still retained their spontaneous sense of humour. These boys were responsible for the bulk of the routine work and much of the successful collecting. . . . We retained these Munchis as collectors, in which role they proved remarkably adept. Coming to know them all by name, I instituted a book in which all they found was entered, so that they could be paid once a month. These men lay on their stomachs for hours on end in the forest, filling little tubes with spiders and small snails, and fought like tigers over the possession of even the minutest. One Dambaike had such a keen eye and such fine fingers that he produced on one occasion nearly a hundred of the precious Podogona alive (they are about 6 mm. in length). They also acted as bodyguard, in which capacity they formed a ring round the house to keep away inquisitive village folk and unwanted humorists. . . . It was Afa also who demonstrated to us the use of luminous fungi and centipedes in night hunting. Both these natural objects give off a strong greenish light and the hunters place them in their hair where they become entangled and act as a beacon to the men in following their leader through the bush. Afa also climbed trees and examined spore by their light."
Sanderson. Cameroons. 85.113.

"Our total staff was twelve. Of these two were descendants of East Indian immigrants and ten were aboriginals of the Arawak tribe. These men were splendid fellows, quiet, willing, cheerful, industrious, and genuinely interested in our odd activities. At the same time they were placid and dignified, and, if unjustly rebuked, would quietly disappear. Most of them were born naturalists, keen and accurate in their observation, and there was not a day that we did not consult them repeatedly on matters connected with the forest life. In any activity requiring care and patience, such as skinning birds, preserving plants, sorting, pinning, or labelling insects, they are likely to be better than the average European. For a party in the bush they are indispensable. To us they were hunters, tree-climbers, boatmen, taxidermists, woodcutters, camp-builders, fishermen, trail-makers, and performed a hundred other duties necessarily connected with life in the bush."
Hingston. British Guiana. 76.19.

"The native assistants were mostly Arawaks—small, slight, very quiet, shy, intelligent people, speaking English perfectly and having a command of available resources, a skill, humour and willingness to help in the worst

excesses of madness shown by the various scientists which contributed so much to the success of the operations that it would be difficult to overrate their services." *O.U.E.C.2. British Guiana.*

"I also had trouble with my half-chronometer watch, but after I had failed, it was finally mended by an Eskimo, John Ell, who filed down a needle to take the place of a broken staff. Though most Eskimo have short, thick, and apparently clumsy fingers they use them with remarkable dexterity and infinite patience. Patience is an Eskimo's greatest virtue and the most difficult for a white man to emulate."

Manning. Southampton Island. 88.235.

RATIONS AND PAY OF CARAVAN

Make all inquiry of the normal rations and pay of men to be employed, and if possible arrange to give a slightly larger ration. Remember that customs may change *en route, e.g.* in the Himalaya down-country servants require different scales from those engaged in the hills, and Muhammadans different from Hindus. Decide when and how rations shall be bought, and what outfit of clothing and shelter can be bought locally. Inquire how far it is possible to live on the country, what are the possibilities of engaging local labour, and whether for the term of the expedition or changed *en route;* what is the custom of the country in providing guides or (as in Arabia) exacting tribal hostages.

"At first they worked under the supervision of Malay headmen, but gradually we replaced all the Malays with Dyak headmen, and found that an all-Dyak labour force was much more satisfactory, easier to feed and handle, and more economical. During my time with the Section, most of the men were Sea Dyaks from the villages on the Katibas, Balleh, and Saribas rivers in Sarawak, recruited for us by the District Officer at Sibu, of course with permission of the Sarawak Government, in parties of about twenty. Each party came from one house, and we found the best results were obtained by keeping them together and making them work as independent gangs. We also employed Dyaks from the districts near Simmangang, but found them rather troublesome. They had a little education and were most intelligent, but inclined to be lazy, argumentative, and not amenable to discipline. The best we had were a party from Dutch Borneo, who had come over from Pontianak to look for work. With very few exceptions the Dyaks were very hardworking, strictly truthful, honest, and really intelligent. They were always happy, and were content with any kind of work. In a very few weeks some of them became really useful to us, learnt to use a prismatic compass, to measure with a chain or tape, and to take a genuine interest in our work. Being jungle people they had a wonderful sense of direction and a good idea of distances—invaluable to us in central Johore. They were at their best and happiest when allowed to have a day's hunting. They did not bring their blowpipes to Johore, but used

spears and our shot-guns. Sometimes, after a successful day, they were too happy, and would sing all night.

They were easy people to feed; we supplied them with rice and small quantities of sugar, onions, and dried peas, which they supplemented with jungle plants and fruits, honey, fish, turtles, and any animals or birds they could trap or shoot." *Bagot. Johore.* 83.208, 09.

"We required a permanent staff of fifty or sixty natives; we solved the problem by employing men for short periods, and before we left most of the young men in the district had worked for us at one time or another. A nucleus remained all through, including two young chiefs who acted as headmen, Morah (now chief of the whole district) and Uyau Usa, a Kenyah from Long Atun. A large proportion of the inhabitants have committed adultery or been divorced. This was very convenient from our point of view, for it meant that several men worked for us all the time to pay fines and alimony to the parties concerned; they provided some of our best collectors because they stayed long enough to learn more about the animals and plants than any one else. No one need be afraid that he will be unable to hire any labour at all, so long as the elastic local morality continues.

Men from all the five tribes represented in the area worked for us. On the whole the Kenyahs proved the best workers and collectors, especially those from the house of Long Atun. They are essentially agriculturists, efficient and contented farmers, very hospitable and generous, though physically not so strong as some other tribes. Punans were the second most numerous of our coolies; they carry greater weights than any others, and a Punan woman will do the work of a Kenyah man. . . . All Punans have an unhappy knack of going dead stupid when it suits them, which makes them useless collectors, while they are the only local people who will go back on their word. Many do not understand Malay—the other tribes speak a pidgin Malay, as well as their own language. Therefore they should not form the nucleus of a party working new or difficult country; though they are valuable as carriers in any ordinary transport scheme. A good many Lirongs and Sĕbops, as well as a few Barawans, worked for us; all were reliable, especially the less intelligent ones." *Harrisson. Sarawak.* 82.389.

"We collected the coolies we wanted through the District Commissioner. Before they understood what was required of them they were not much use, but after a few weeks they settled down and worked very well. We gave them no special clothing but a ration of 1 lb. rice, ½ lb. dates, and 2 oz. ghi."

Stafford. Somaliland. 78.105.

"Daily rations arranged for and issued during the Shaksgam expedition:

Pathans and Kashmir Muhammadans (five), each: Wheat, *Ata,* 1 lb.; Rice and *Dall,* 1 lb.; Salt, ½ oz.; *Ghi* (clarified butter), 2 oz.; Sugar, 2 oz.; Tea, ½ oz.; occasional fresh meat, roughly the ration normal to Kashmir for Kashmiris.

Gurkha Sepoys (three), each: Wheat, *Ata,* 12 oz.; Rice, 12 oz.; *Dall,* 3 oz.; *Ghi,* 2 oz.; Salt, ½ oz.; Sugar, 1 oz.; Tea, ½ oz.; occasional fresh meat, roughly the Army ration.

Muhammadan pony-men (seven), Muhammadan porters (three), Buddhist porters (twenty-two) (includes caravanbashi and head porter),

engaged at Leh, each: Barley, *Satu*, 1 lb.; Wheat, *Ata*, 1 lb.; Tea, ½ oz.; Butter, 2 oz.; Salt, 1 oz.; Sugar, 1 oz.; Tobacco, 1 oz; occasional fresh meat.
Issued in *seers* and *chittaks:* 1 seer=2 lb.; 1 chittak=2 oz."

Mason. S. of I. Report.

"As regards porterage it is perhaps interesting to note that one of the objects of the expedition [6 Europeans] was to cut down the number of porters to the minimum in order that the expedition could live on the country. This was achieved by excluding rigorously unessentials as far as possible. Actually, we never employed more than seventy porters, and these included nine men carrying unessentials in the form of cinematographic and photographic apparatus." *Smythe. Garhwal.* 79.3.

Prepare schedules of rates of pay, rations, and loads. Arrange for carrying followers' rations in bulk, and if they are in bags to weigh periodically to prevent theft. Make one man responsible for issue daily or at short intervals. Consider providing occasional luxuries, *e.g.* rum at high altitudes, and plenty of sugar; also tobacco.

Climbing porters are now registered by the Himalayan Club, and there is much competition at Darjeeling to be registered. Each man has a chit book with a record of his past services. A registered porter will carry twice as much as a local coolie and do twice as much in camp, but their numbers are limited. Rates of pay for porters and coolies can be obtained from the local Secretary of the Himalayan Club or from local authorities. Coolies along the route are engaged from the Lumbardar (village headman). It is important to see that the headman gets a present, but the coolies get the pay. Women coolies carry just as much as men.

Be careful to observe standard rates of pay. Much dissatisfaction has been caused in the end by the lavish expenditure of a few expeditions.

"Followers were accommodated in Bell-tents, specially made by the Elgin Mills, Cawnpore. Twelve men could sleep in each tent, if necessary. Each tent weighed 60 lb. complete with poles, pegs, and bag, and they were very good.

The following articles of clothing were issued to all followers: 1 Balaclava cap; 1 woollen jersey; 1 pair woollen gloves; 2 pairs woollen socks; 1 *puttoo* suit; 1 poshteen (sheepskin coat); 2 pairs *Pabboos* (or 1 pair boots); 3 blankets (or 1 numdah and 1 blanket); 1 warm puggaree; 1 pair puttees.

This scale was found adequate. The felt numdah was issued instead of two blankets and was more suitable. Soft leather *pabboos* are more suitable for Ladakhis than boots; the two pairs just lasted during the expedition with careful mending, the skin of dead horses being used for this purpose. Gurkhas, Kashmiris, and Pathans preferred boots which were suitable for them. Boots must be carefully fitted." *Mason. Shaksgam.*

"The system of organizing the porters into sections, each under the command of an under-sardar, was most satisfactory and was appreciated by the men themselves, amongst whom there was always keen competition to gain the coveted stripe. Some members criticized this system as being too military; but any one who has had to deal with 150 or so entirely untrained and undisciplined men will quickly realize that some such method is necessary, even if only for the purpose of moving the porter corps from one place to another.

A head sardar, whose chief duty is to see to the porters' feeding arrangements and to ensure that every man does his fair share of work, will always be necessary." *C. J. Morris. M.E.E.* 1936. 89.501.

"We could afford to equip with proper Alpine equipment only a certain number, I think six, of the local porters, our own ten Sherpas from Darjeeling, and two Gurkhas N.C.O.s we took with us. We therefore could not make any unequipped people sleep on snow, so those who were unequipped used to sleep at Camp I, 16,500 feet, or at the Base Camp at 15,500 feet, and make themselves useful while we were climbing the mountain and working the way out by bringing up fuel and food." *Smythe. Kamet.* 79.12.

"I should like here to pay a tribute to the skill and willingness of the Mana men. They had not, of course, to undergo the hardships which the Dotials had suffered on our first journey, but before very long I came to have considerable respect for them as cragsmen, while their ever-ready wit and carefree laughter will remain as one of my pleasantest memories. They and the Sherpas came to be the very best of friends and I think there was a measure of genuine regret when the Mana men had to take their departure."

Shipton. Nanda Devi. 85.318.

"The porters were mostly selected from the neighbourhood of Khalatse, in the Indus valley. Without exception they were first-class men. They came quite willingly for Rs. 20*s.* a month with rations and warm clothing. They were placed under the charge of our shikari, Kunchuk, who was excellent man in every way." *Mason. Shaksgam.*

CHAPTER IX. TRANSPORT

PORTERS AND COOLIES

ALTHOUGH in many parts of the world transport by porters is being rapidly superseded in open country by mechanical transport, it is still required in forest and in mountains. The terms of engagement, rates of pay, and rations have been dealt with briefly in Chapter VIII. Details vary locally. A few general principles are that one European member at least should have a thorough knowledge of the language of the porters, to avoid whenever possible having to have an interpreter; that a caravan engaged through the head-man is responsible to him more than to the employer; that there should be wherever possible a nucleus of efficient natives as permanent members of the expedition, feeling some responsibility for its welfare; that medical inspection of these men is essential.

"In Sadiya we spent some days in dividing our baggage into loads of 60 lb. The coolies for this stage of the journey had been recruited from the Digaru Mishmis. There were sixty-five of them under the nominal command of a certain Nimnoo, reputed to be the most influential Headman among them, but this meant little as the Mishmis are very independent, and their Headmen have little real control over them. . . .

Though cheerful enough among themselves, the Mishmis were a surly lot in their dealings with us, always arguing, and generally making themselves unpleasant." *Kaulback. Assam.* 83.179

"I had when I left India twenty-four loads, a load being never more than about 50 lb. These included two boxes of stores, a couple of tents, my bedding and that of two permanent servants with me, and of course a vast quantity of drying paper for plants. After travelling for about a month and having reached a convenient base in Tibet I dumped half my loads, put them in a sort of local cloak room as guarantee that I was returning there, and set out with twelve loads on a journey which I thought would keep me absent for about a month. I was actually absent for ninety days. Of those twelve loads two or three were botanical drying paper; I had also my bedding and that of my servants, tents, and a few cooking pots and stores. For the most part, my servants and I lived on the country." *Kingdon Ward.* 88.412.

"All food and equipment had to be brought up by coolies, and for this we used mainly Punans. It was necessary to keep twenty men on top for collecting, camp, and emergency purposes, which meant large quantities of rice. One man eats one *gantang* of rice in four days, and one man will carry four *gantangs* of rice (enough for himself for sixteen days), so that to keep the high camp supplied with rice alone nine men had to come up once a week. This meal-portage relationship has an important bearing on all travel in Borneo,

for it is clear that without an elaborate advance organization and depot system it is impossible for any one to travel more than about fifteen days in an uninhabited area." *Harrisson. Sarawak.* 82.393.

"No pack animals of any sort could be used, and away from the rivers all stores had to be carried by coolies. The Dyak carries all loads on his back in a basket made of split rotan with shoulder straps and a brow-band of beaten bark. A good coolie can easily carry a load of 100 lb. several miles a day through jungle and swamp." *Bagot. Johore.* 83.207.

"Travel in New Guinea depends on native carriers, and ninety natives were employed by the combined parties. The Bena Bena area was traversed by parties comprising thirty carriers. The maximum load that could be transported without delay was about 35 lb. per native. The radius of travel was seven days' march when food supplies for the carriers had to be transported. Aeroplane reconnaissance indicated the possibility of obtaining food from the natives encountered on the march, and the range of travel was increased to ten days' march. Shells, beads, and steel articles were the principal articles of trade with the natives. Shells were preferred by the inhabitants of the Wahgi Valley and the areas to the west, while beads were readily disposed of in the Bena River area." *Spinks. Central New Guinea.* 84.414.

In general, payments to porters are better made in the presence of but not through a head-man or other official; but contracts for transport, which have often to be made with officials, may make this impossible, and amongst some tribes of Burma a payment made to a coolie is immediately handed to the Tibetan or Chinese overlord. Payments to individuals should be laid out on a table, and the recipient given plenty of time to count. Pay separately, and preferably at the mouth of the tent. Do not allow other men to crowd round.

Efficiency of African porters depends on character and knowledge of head-man. The old type used to very large caravans no longer available, but good substitutes may be found from men with long service in King's African Rifles or West African Frontier Force. A good head-man identifies himself with the interests of the leader. For a month's journey away from base one European requires from eighteen to twenty porters; two with one tent each about twenty-five. The leader should have knowledge of the vernacular since success depends greatly upon mutual confidence between himself and the personnel. *C. W. Hobley.*

"Porters—or carriers as they are called in West Africa—are excellent, despite the repeated affirmations of European residents to the contrary. We never once had anything stolen, lost, broken, or dropped, although all

crockery and glass travelled in open boxes poised on their heads, and one thousand glass tubes and bottles accompanied us everywhere. Much of life in the Cameroons is concerned with 'walka-walka,' as it is popularly termed by the African, and fun begins when sufficient carriers are at length gathered together. The carriers we employed were of two species, those that had carried for white men before and those that had not. The former had preconceived ideas on the length of a day's trek, which did not coincide with our intentions. Europeans have a most disagreeable habit of leaving at dawn for a march of about 17 miles, on an average, to a previously appointed location where breakfast is served. Our method was to have a leisurely breakfast in pyjamas, whilst our scientific gear was packed, and then to walk as far as we could until tea-time while it was at least warm and sunny. This gave the latter variety of carrier a loophole for disappearing miles ahead, as the native covers tremendous distances when by himself, and also caused several commotions in the early morning, as carriers got bored with waiting by 9 o'clock and often retired to the village for a day's siesta.

A little band of twelve Munchis, who remained with us throughout the expedition for collecting as well as carrying, proved our most valuable asset, owing to their almost superhuman powers of endurance. On one occasion they travelled with me alone from Ikom to Mamfe, a five-days' journey, which they accomplished in forty-eight hours. . . . They complained bitterly if they were given light loads, and the only punishment that had any effect upon them was to make the ringleader of the trouble walk without any 'cargo' in front, where he was subjected to an unending fire of jests and taunts by the others, with constant allusions to his weakness and his mother's reactions should she see her son thus degraded!"

Sanderson. Cameroons. 85.120.

"It was customary to give the porters a cerebos salt tin full of *bulo* (Eleusine corocana) flour besides salt and blankets. This amount of flour corresponds to a native measure, a *kiraba*, which is about $1\frac{1}{8}$ lb. Loads are made up to 45 lb., which is rather less than the weight of loads carried on safari on the plains; moreover a day's safari is much shorter than elsewhere, and there are numerous halts either because of difficulties in the way, or for rest, or in order to make a fire for warmth. Ideally one should take all loads with one and send men back as loads are used up. This is however not often possible as the porters are seldom all ready to start with the expedition. Moreover during the journey men often go sick or fall out for other reasons more quickly than the loads of food are used up. It is important that if possible there should be two Europeans on all expeditions. If there is no European with the cutters who make a way in advance of the porters the natives will often go off at right angles to the direction selected, either because the path is easier or for some reason known only to themselves. If there is no European at the rear of the party groups of porters, on reaching a convenient rock-shelter, will decide to camp there instead of catching up the main party. . . .

It had been a short journey with many delays because of the large heath trees which grew close together with low horizontal branches, too big to cut through, which compelled the porters to transfer the loads from their heads to their shoulders while passing under the trees. This caused some of the

porters literally to weep, and it was a very discontented safari which dribbled into camp. . . .

We soon met the porters. They had found a rock-shelter on the way up and camped there regardless of the fact that we were ahead without food or shelter." *Humphreys. Ruwenzori.* 82.484, 97, 99.

In China much travel is done in chairs with three bearers, two working and one resting. They cover 20 miles a day on the level. This is calculated in terms of li—each one-third of a mile, but the li varies with the character of the country, being shorter uphill than down; practically the measurement is by time, nine to ten li per hour. Payment is by arrangement; the charges are mostly regular and there is no great advantage in exceeding them. Inquire the local rate. You will be asked twice what is customary. You offer half the normal and eventually adjust to a little above normal. A gift at the end is better than over-paying. Find out if possible what the missionaries pay. It is impossible to force a quick decision. *G. B. Barbour.*

BACK-PACKING

Carrying on the back is not always the part of native porters or coolies. In the ultimate stages of mountaineering expeditions the loads have been carried by the European members of the expedition themselves, as in the ascent of the Watkins Mountains by Augustine Courtauld's party in 1935, and in the ascent of Nanda Devi in 1936.

"Most of our travelling had to be done below the snow-line at heights of less than 3000 feet, and we were forced therefore to carry all loads on our backs. We found that there was nearly always dry glacier at these low heights, and sledging over dry glacier would have been impossible. Our first journey up the Ebba Glacier on August 8 showed that this route affords a perfectly easy way to the interior. After depositing stores at Camp 1, Pirie and myself climbed the hill P 2. We had learned by now that the most efficient way of climbing thereabouts is to choose a route with as much ice on it as possible and use crampons." *Jackson. Spitsbergen.* 78.278.

MAN-HAULING

The expeditions of Amundsen and of Scott to the South Pole in 1910 showed so clearly the advantages of dog-hauling on long journeys that man-hauling of sledges is now restricted to short journeys in difficult country, as the coastal mountains of East Greenland.

"It is only necessary to read accounts of the hardships suffered by man-hauling parties, to know that it is a mistake. Instead of getting pleasure and exhilaration from the actual travelling, the men get played out slogging on

from morning till night, and their resistance to cold and fatigue gets worn down. Consequently it becomes an enormous effort for them to give their best to their scientific work. In spite of all this effort the records of the best man-hauling journeys show that under average conditions it is not possible to travel more than 12 miles in one day." *Watkins. Labrador.* 75.113.

". . . the sledges . . . were the ordinary Nansen pattern with polished metal runners (Albata metal). We came to the conclusion that even for light loads it is better to keep to the full-length 11-foot sledge. The man-harnesses were made by Messrs. Camp and Sports from a set of Shackleton pattern lent by Dr. Longstaff, and proved satisfactory in most cases. One or two men felt some sickness and discomfort from the pressure on the stomach after a long spell of pulling. More attention should have been given to the individual fit." *Courtauld. E. Greenland.* 88.206.

"*Equipment for six men, man-hauling and packing, E. Greenland, summer* 1935: 2 sledges; 8 ration boxes; 8 quarts paraffin; 2 small Primus stoves; 3 tents; climbing rope (2 × 80 feet); climbing line (2 × 120 feet); lash line; 3 ice pitons; 6 pair crampons; 3 pots and lifters (Camp and Sports); 6 aluminium mugs; 6 spoons; 2 ground-sheets (for covering sledges); 1 tin matches (waterproof); 6 man-harnesses; string; copper wire; 2 pulley blocks; screwdriver; pliers; lantern and candles; 1 theodolite [extra light 3 inch]; 3 aneroids; 1 hypsometer and 3 thermometers; 2 dry compasses; 2 min. thermometers; 3 small cameras; *Nautical Almanac* pages; paper; pencils; 2 spare goggles; medical outfit." *Courtauld. E. Greenland.* 88.208.

"We started across the ice-cap early in the morning of July 1, each of the sledges being loaded with 690 lb. of food and equipment. For hauling the sledges, harness of Shackleton type was employed provided with a 10-foot rope and eye-splice which fastened into a toggle attached to the front of the sledge. The temperature was well above freezing and the surface very soft. This, with the upward slope, made man-hauling distinctly arduous [three men to a sledge], and we only succeeded in covering 2 miles on our first day. By this time however we were clear of the crevassed area, and the outlook for the future seemed more promising.

We were in a thick fog, and in order to keep our compass-bearing we followed one another, the second sledge shouting to the first if their tracks deviated from the straight course. It was our first experience of the strange sensation of seeing no horizon, and the snow in the foreground merging into the sky without any break. Under these circumstances sledging is a monotonous occupation and one is fatigued rather by boredom than physical weariness. Owing to the heavy rain and fog during the greater part of the journey, it was necessary to pull in oilskins and sou'westers—unusual clothing for sledging." *Roberts. Iceland.* 81.292.

"Before leaving England it has been decided through the advice of the majority that dogs should not be taken, partly on the grounds of the relative shortness of the journeys to be covered—the longest direct journey, that from Treurenburg Bay to Petunia Bay, being less than 100 miles—and partly because it was considered that the country was unsuitable. This was a mistake. The rapidity of dog transport would have enabled party A with the

Wild phototheodolite to take full advantage of the few periods of fog-free weather, whereas much of this was spent in travel. The country proved ideal for dogs as very few crevasses were encountered. This is a case when full use ought to be made of local knowledge and experience, since all the trappers encountered agreed that dogs would have been a very great help. It is worth pointing out that dog teams are obtainable at Advent Bay."

Glen. Spitsbergen. 84.108.

SLEDGING

The speed and comparative simplicity of sledging with dog teams has been realized to the full only in post-war years. Its technique has been studied by all recent Polar expeditions, for there is no question that it is the best general method. Man-hauling is suitable for short journeys in mountainous country; mechanically propelled sledges have not yet proved themselves. In general an arctic traveller must learn the art of dog-driving, and a good driver with a trained team will keep the dogs fit and well. Only a very long and arduous journey may necessarily include a certain degree of remorseless use of the dogs, disagreeable to the feelings of dog lovers, but essential to success. There seems to be no doubt that three out of four Englishmen become good drivers in a season, and perhaps one in ten very good.

Where it is possible to travel by sledge and dog team as in Greenland, it is sometimes best to live with Eskimos at the base; to employ them there for hunting to save time, for sewing, and for making travelling and hunting equipment; to learn their technique in travelling and hunting. But travel alone for speed and punctuality; one should seldom make plans essentially based on cooperation with Eskimos, and the same may be said of many other people in the world.

"On a long journey there should be one dog team to every man; the loads on each sledge will then be small, and long distances can be covered. A two-man unit can remain out very easily for six weeks without restocking provisions. At the beginning of such a journey the total weight of dog food and man food on each sledge will be about 500 lb. Since a seven-dog team should not be made to pull more than 700 lb. to get the best results from it, there is still room for 200 lb. on each sledge. With this load it should be possible to do 25 miles each day." *Watkins. Labrador.* 75.113.

"A sledger's mind becomes very shallow, and can measure events only in contrast with things that have just happened." *J. M. Scott. Labrador.* 136.

"The whole journey was made very efficiently. Scott was the only member of the party who had ever sledged or used dogs before. In spite of this, each man had his own sledge and team of seven dogs. With their heavy and

awkward loads they averaged 10 miles a day on their journey from the Big Flag depot to the Ice Cap station (this includes the time spent in their tents during bad weather, and also the time spent taking the observations). They did the return journey from the Ice Cap station to the base in four and a half days, an average of 28 miles per day." *Watkins. B.A.A.R.E.* 79.358.

"On an ice-cap journey the only difficulties to be found are the weather, crevasses, and rough ice (near the edge). Driving dogs on the Ice Cap is a simple matter; in fact it cannot really be called dog driving, any more than walking on skis on the Ice Cap can be called ski running. In Arctic coast travel it is necessary to have an accurate knowledge of the thickness of ice which will carry the weight of a man on skis or without them, of a lightly loaded sledge and heavily loaded sledge. This thickness will, of course, vary as you go up a fjord, since the water at the head of a fjord is always fresher than at the mouth, and freshwater ice has a different strength from salt-water ice. Then in the spring, when the ice is beginning to melt, it is necessary to know the places where the ice is likely to have been cut away from underneath by currents, and later great skill is required to sledge over drifting ice-pans. The rough ice met with in pressure ridges on coast travel is far worse than any rouch ice which is ever found on the Greenland Ice Cap.

Owing to open water it is frequently necessary to cross the points of land on a coast journey rather than go round them, and this necessitates travel in steep mountainous country. Lastly, on a coast journey, owing to the rough nature of the country, it is usually impossible to carry more than a few days' food, so that a knowledge of Eskimo hunting methods is necessary in order to secure food for the journey. Owing to the varied nature of coastal travel it takes a man about three or four seasons' experience of driving different types of dogs through different types of country before he can be a really experienced coastal dog sledger, whereas a man can learn to drive dogs successfully on the Greenland Ice Cap in a few days."

Watkins. B.A.A.R.E. 79.363.

"Rymill and Hampton left the eastern edge of the Ice Cap on their 450-mile journey on 12 August 1931. They had with them two sledges and two kayaks. The kayaks were for completing the last 100 miles of the journey down a long fjord from the western edge of the Ice Cap to Holsteinsborg. We had been told that it would be quite impossible to carry kayaks on sledges on a long journey since they would be broken whenever the sledges overturned or be eaten by the dogs. We did not see why this should be so, and we realized that if we could show that it was possible to carry kayaks on a sledging journey it would open up new possibilities in the way of Arctic transport. Rymill and Hampton rigged up a special framework on top of the sledges to keep the kayaks out of reach of the dogs and to protect them if the sledges should overturn, and in this way they were able to carry them the whole way across Greenland without any damage.

The first part of this journey they did in extremely good time, the weather and surface conditions being good, and they were able to average as much as 23 miles a day for as long as a week at a time. They had an aeroplane compass mounted on the back of the sledge, and they steered their course in the same

way as an aeroplane. This saved the frequent stops to take bearings which are usual on a sledge journey." *Watkins. B.A.A.R.E.* 79.471.

"Three men is believed to be the best number for a long journey. As the pace of the whole party is that of the slowest man, the team must be as compact as possible. Three men should be able to include the necessary rôles of cartographer, geologist, glaciologist, meteorologist, and photographer, and three is a safer number than two, as if one man breaks down there are two others to assist him." *Lindsay. Greenland.* 85.395.

"For a long sledging journey it is usual to lay depots along the first part of the route during the preceding summer, but this was not in our case possible owing to the peculiar conditions of the Greenland ice-cap. The great force of the winter gales, the wind sometimes approaching 100 miles an hour for two or three days a week, causes any object on the ice-cap to be completely buried by snow-drift. One of Peary's journeys was virtually wrecked through a pemmican depot being lost in this manner and in 1931 the British Arctic Air-Route Expedition had a similar experience. A large dump of wireless stores and ration boxes was put down, and when a party went to fetch it two months later it could not be found. Direction flags marked its position to within 100 square yards, but although they probed the ground the men were unable to locate the depot." *Lindsay. Greenland.* 85.395.

"The way to the depot we marked with red flags every half-mile and the dump itself with a huge black flag that could be seen nearly 2 miles away." *Lindsay. Greenland.* 85.398.

"On July 11 we put everything on to two sledges; we did not however abandon the third sledge but trailed it behind us, thinking that if later we met crevasses it would be better to have our valuable eggs in three baskets instead of in two. The load of the third sledge had by this time been reduced with the consumption of dog-food and man-food from 1000 lb. to about 750 lb., and this we were able to divide between the other two sledges. This procedure meant very hard work, starting sledges weighing about 1150 lb. (by swinging the front of them from side to side); but it left one man free to ski ahead of the leading team, which enjoyed being led and pulled well behind him." *Lindsay. Greenland.* 85.399.

"The day's run would vary from about 25 miles in fine weather to as little as 10 or 12 miles in deep going or in a snowstorm, the fatigue experienced always being in the inverse proportion to the distance covered. During the last 400 miles we sometimes had great difficulty in getting the front team to pull ahead, for the dogs had ceased to be interested in a man leading on ski. It is almost impossible to speak too well of these dogs; they had been in harness for fifteen weeks and had covered about 1200 miles. Starting with very heavy loads, they had pulled their sledges in all weathers and on every kind of going, over rock, grass, pack-ice, fjord-ice, and glacier-ice; through morasses and mud and fast-running rivers, and through every condition of snow." *Lindsay. Greenland.* 85.401, 03.

"Lightweight sledge boxes were designed by Croft, from his experience on Martin Lindsay's trans-Greenland Expedition, 1934. They were strengthened by a framework of wire, which was found adequate for protection

against the hard usage to which they were subjected. 1-inch Italian rope was used for lashing, and was thoroughly satisfactory for that purpose, as it rarely froze, and was easy to splice." *Glen. North East Land*. 90.195.

SLEDGES

Sledges are of two principal types called by the convenient and accustomed names of the Nansen sledge and the Greenland sledge.

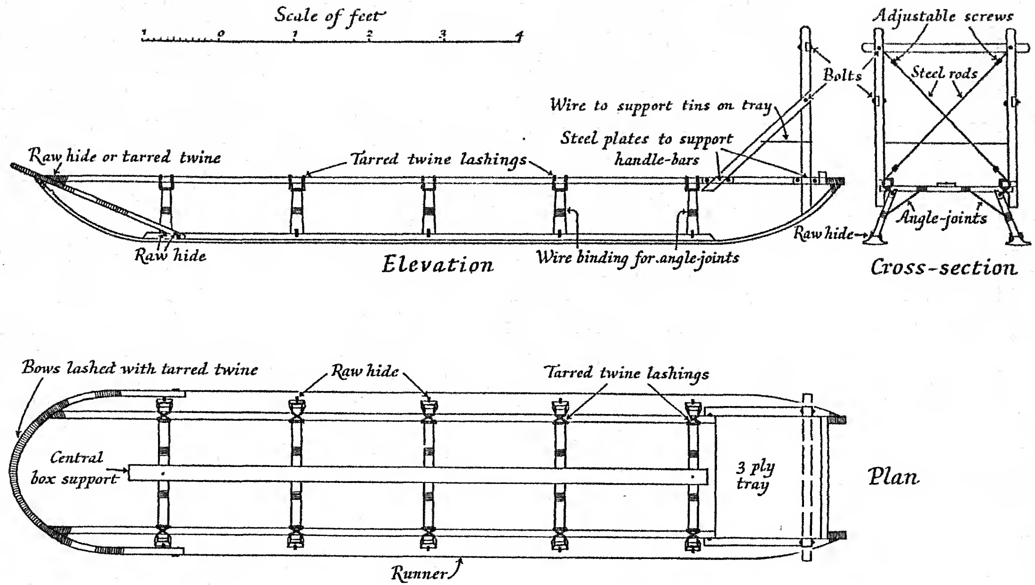
The NANSEN SLEDGE is a light skeleton framework built up on a pair of long skis, the joints lashed with strips of raw hide, so that it is flexible and "moves like a snake." It was developed by Nansen, and has been modified largely by recent British expeditions. Suited to ice-cap travel, but not strong enough for knocking about on sea-ice or over rocks.

In the American Arctic a very much heavier type of open-framed sledge, rigid, has always been used by the natives, and the fashion followed by Stefansson, Storkerson, and others (see *Polar Record*, January 1937).

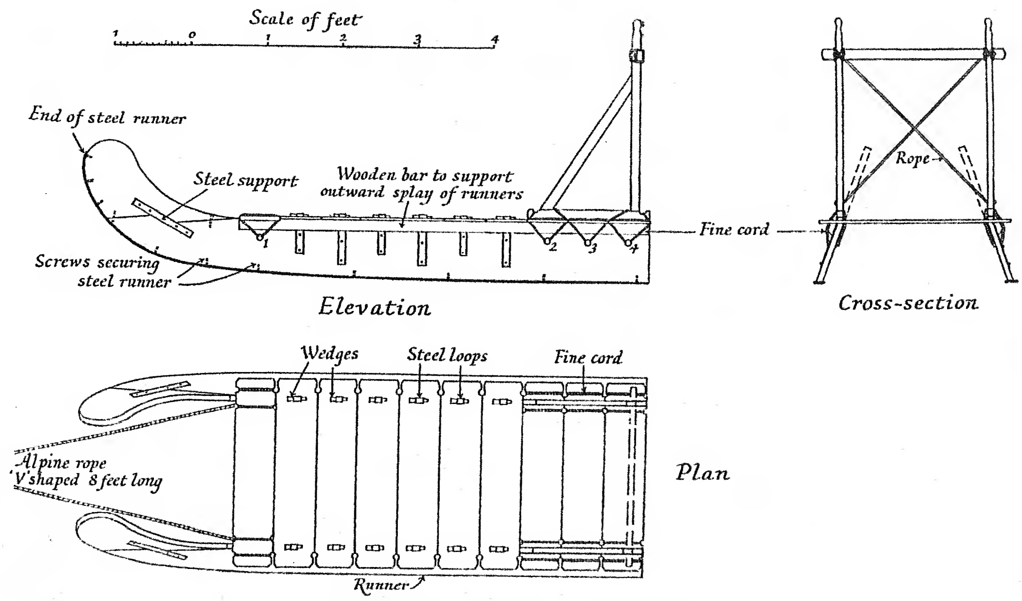
The GREENLAND SLEDGE runs on the lower edges of two solid sides curved upwards in front, decked across with planks lashed or wedged to the sides, to form a box platform, not nearly so flexible as the Nansen sledge, but not too rigid: shorter and more suitable for rough work over pack-ice, and weighing about twice as much. Used for centuries by the Eastern Eskimo of Greenland, Labrador, and Baffin Land, and sledges of this type but of better materials by Rasmussen, Peary, Sverdrup, and other explorers. The Peary sledge was a modification of the Cape York variety, long and narrow.

Both patterns have handle bars at the rear by which to steer. The runners of the Greenland sledge are shod with steel: the skis of the Nansen sledge are generally bare hickory, but have been shod with German silver and similar metals.

German silver is an alloy of copper 55 to 60 per cent., nickel 5 to 35 per cent. and the remainder zinc. The alloys with high nickel content are stronger, resist corrosion better and are a better colour. It is widely held that metal is slow at low temperatures, but there is little experimental evidence upon the subject; the opinion is derived from the experience of hard metal edges for racing skis. Edges of Duraluminium have been used but apparently not German silver. Presumably steel is strongest; certainly Duraluminium is lightest and would be worth trying.



NANSEN SLEDGE



GREENLAND SLEDGE

The Lindsay expedition on the Greenland ice-cap in 1934 used three Nansen sledges; the Oxford University Arctic Expedition in North East Land 1935–36 had three Greenland and five Nansen. The following notes are based on Andrew Croft, who was on both expeditions.

NANSEN SLEDGE

Framework of well-seasoned ash, not too dry: recently made too light. Uprights (or better, columns, since they are not upright but splayed outwards to make angle 110° with the cross-bars) dowelled into the skis, and braced to cross-bars by steel struts with enlarged terminals sunk into columns and cross-bars and bound with heavy steel wire soldered. Cross-bars $1\frac{1}{2} \times 1$ inch lashed to columns with raw hide nearly always white whale, 0·3 inch wide; longitudinal bars lashed to cross-bars with tarred twine. Cross and longitudinal bars should not be weakened by grooving to take lashings.

The bow is made of two strips of ash, of semi-circular section, bound tightly with tarred twine, bent to shape of hair pin and lashed to the frame so that it points upwards to lift over a hummock; correct tilt shown in photograph opposite p. 235 of Lindsay's 'Sledge,' or in drawings on pp. 130, 131, *q.v.* Bow generally made too weak.

The frames may be made in England; the hickory skis 3·8 inches wide best obtained from Hagen of Oslo. The bearing surface slightly convex: dressed with five or six coats of wood-tar and linseed oil mixture. Curved well up and pierced at each end, to take bow-lashing, thus reversible. German silver (or perhaps nickel steel) sheathing for skis probably desirable though expensive and heavy: perhaps compromise by sheathing 2 feet at bow end.

Below −20° C. coat wooden skis with mixture of porridge or sawdust, blood, and water, heated and spread evenly, brushed over with hot water and left to freeze. This lasts several days and runs beautifully.

Good average length is 11 feet overall with clearance below cross-bars at least 8 inches and better 10 if breadth of box platform 20 inches. Extra height saves broken cross-bars, gives bow more elevation, and allows more room to lash spare runners and poles underneath; not noticeably more top-heavy.

The box platform of Nansen sledge being open longitudinal bars, ration boxes should be packed cross-ways, each as long as the platform is wide: say 20 inches: width and depth designed to take neatly the bulkiest ration: say dog pemmican. Boxes lashed on with manilla hemp rope 0·3 inch diameter.

Between the handle bars screw a square three-ply tray to the plat-

form to steady small boxes and paraffin cans; and wire round the handle bars to keep these things from falling off.

For going downhill have a drag rope tied to a pair of opposite columns, and drop it over the bow so that as sledge runs forward it is looped under the runners about 2 feet from rear ends: thickness of rope should be varied with slope. See also management of dog team downhill, p. 138.

GREENLAND SLEDGE

Well-seasoned ash throughout, painted or varnished to prevent waterlogging. Runners about 9 or 10 inches deep, by $\frac{3}{4}$ thick, splayed out to 110° from platform, shod with highly burnished spring steel $1\frac{1}{4}$ inch wide by $\frac{3}{16}$ thick, tapered in front to curve round the blunt-nosed bows screwed and glued to runners in front.

Ten or eleven cross boards, of which front $\frac{2}{3}$ inch and others $\frac{1}{3}$ inch thick: former let in to runners to bring top level. Front and three rear boards lashed to runners with raw hide, to give some flexibility under shock; or with turns of manilla cord $\frac{1}{8}$ inch diameter through the numbered holes in runners: about 7 feet for each lashing; remainder secured by wedges through loops of steel strip screwed to runners and projecting through square holes near ends of cross boards. Shaped wooden bar along top outer edge of each runner, fitting close under the slightly projecting cross boards (instead of the steel braces of the Nansen sledge) prevent runners splaying further.

Width of box platform between wedge-loops just more than width of two ration boxes and length just more than length of three: say 64 inches. If both kinds of sledge in use, design so that box platforms take say six ration boxes in either arrangement, *i.e.* six crosswise or two threes lengthwise.

The "forearm" or pulling rope is a length of about 8 feet alpine rope threaded through holes No. 1 in runners and knotted outside. To this the trace rope is attached. The uprights of the handle bars are $1\frac{1}{2}$ inch fore and aft by $\frac{3}{4}$ inch: lashed with manilla cord to the runners through holes 2 and 4.

The above descriptions and drawings refer in detail to the Nansen and Greenland sledges built in England for the North East Land Expedition (Glen) of 1935–36. Lindsay's Nansen sledge was very similar. The Greenland sledge is a British version of the sledge used on the west coast south of Cape York.

For the British Graham Land Expedition Messrs. Rymill and Hampton modified the design of their Nansen sledges by making

both bow and stern heavier, lengthening the forward strut of the handle bars to lash it to the runners, and in many details, for which see the book of the expedition. For both types they adopted from the American Arctic sledges a brake of which they speak highly: a flexible lath of hickory lashed underneath the middle crossboards and projecting a little at the stern, with two metal spikes below; the driver presses it down with his foot (see Rymill book).

"After making our dog teams up to ten each we started back to Lake Fjord. The surface was still heavy, but with our large teams we were able to do the 131 miles in five travelling days, arriving on March 5. We were using the ordinary type of Nansen sledges. These were not nearly strong enough, and we had to rebuild them after any journey which included pack-ice travelling." *Rymill. East Greenland.* 83.369.

"Two Nansen 11-foot sledges and Shackleton-pattern man-hauling equipment were used. On the advice of Sir Douglas Mawson the runners of these sledges were not sheathed either with steel or with German silver, and they proved extremely satisfactory." *Glen. Spitsbergen.* 84.108.

"The wood *komertik* runners are shod with either steel or whalebone. Steel shoeing is always used in the fall and on land in late spring when rocks are numerous, as bone is soon spoiled by scratching. Bone slides far more easily; and ice, put on by means of a wet piece of bear skin, rubbed along it, will not crack off as it will from iron. During the cold weather, mid-November to late March, bone-shoeing is usually, and iron always, covered with an inch layer of mud. Chopped out of the ground with an axe, the mud is thawed and broken up; and it is usually of peaty consistency and must contain no grit. Balls about 6 inches diameter are spread round the shoeing and about 1½ or 2 inches up the wood. In a few hours the mud is frozen solid, then it is smoothed by planing or scraping with a knife. The mud must be covered with a thin glaze of ice. Providing the sledge does not bump down on glare ice or hit a rock, the mud will last all the winter. On the average however it has to be patched about twice a week. As the mud is more likely to break on the bows, a strip of walrus hide is sometimes nailed there instead. If during the course of the day the ice wears off, the walrus hide drags far worse than iron; it is therefore never used on the flat of the runners, though according to Dr. Rasmussen it is occasionally thus used in Greenland.

The ice glaze must be renewed daily; except in warm weather or on salt ice, the old ice is planed off before putting on the new. In cold weather the ice must be very carefully put on. If the water is too cold the ice will turn white, and will not slide; if too hot the mud is thawed and gets on the bear skin. With the temperature above zero the water can be almost cold and several coatings must be put on. In spring when the temperature is around freezing point, a slob of snow and water is used or even small pieces of ice cut out with a saw and frozen on during the night. In this way the mud is preserved and can be used even when the snow is wet and rapidly thawing. On the mainland south of Chesterfield, where whalebone is scarce, mud is

sometimes used well into May. On Southampton Island however most Eskimo are using bone by April, whalebone being more plentiful there."
Manning. Southampton Island. 88.233.

"Nansen sledges were used and were found excellent in every way. They ought to be well soaked with linseed oil some time before leaving, and it was found that it is well worth waxing their hickory runners. Decking and the fitting of handle-bars increase their efficiency. Ordinary climbing rope is probably as good as anything for lashings and harness ropes. The Shackleton-pattern harnesses were too short for tall men, and it is important that they lie easily round the hips." *Glen. Spitsbergen.* 84.129.

"An unsupported sledging-party of three men intending to stay out for ninety days will start with their three sledges loaded each with at least 1000 lb. To stand up to this weight the sledge must be of the finest material and workmanship. Ours were of the Nansen design made at Byfleet of ash and hickory by E. L. Pitman, an aircraft carpenter, and they were a great improvement upon those turned out by mass-production methods in Norway. In places they were specially strengthened to a new design, a cross-section of which has been lodged at the Polar Research Institute. The weight of each sledge was 60 lb.

Unless the surface is fairly hard and smooth it is not possible to start off such heavily loaded sledges from a standstill. Even then the dogs need to be trained to take the pull all together at the word of command, and the men must be of strong physique to be able to ease the lie of the sledge by jerking the front of it from side to side." *Lindsay. Greenland.* 86.247.

"The sledges used on this journey were of the Greenland type. They were 12 feet long and 30 inches wide, and weighed about 120 lb. each. The solid runners were shod with mild-tempered steel covered with a detachable $2\frac{1}{2}$-inch wide hickory ski. In cold weather an ice shoe of frozen peat was put over the hickory ski. A canvas-covered frame about $4\frac{1}{2}$ feet high was built over the sledges, and each sledge was provided with a light, wood-burning stove. These 'covered' waggons were found quite comfortable whenever sufficient driftwood was obtainable, and did away with the often difficult and unpleasant task of erecting a snowhouse or tent in the dark after a long day's journey. East of Point Barrow, where in many places no driftwood was to be found and Primus stoves had to be used for cooking, the inside of the tent sledges soon became badly frosted and the canvas cover eventually had to be discarded. On arrival at Aklavik our sledge odometer registered a travelled distance of 1600 statute miles or an average of 26·4 miles per travelling day."
Porsild. Arctic Canada. 88.4.

"Motor tractors are good for taking heavy supplies backwards and forwards between camps, and for journeys where no rough ice or very steep hills are likely. In rough ice motor tractors are too unwieldy and too heavy to manoeuvre successfully. And on thin sea-ice, owing to their weight, they are dangerous.

Horses pull large loads and are easily managed, but they have one great disadvantage for a long sledge journey: the food which has to be carried for them is very bulky and cannot, in an emergency, be used as food for the men.

Also in a high wind a wall has to be built for them at night, and this means extra work for the men. Their greatest use on an expedition would be on short journeys when heavy work was required, such as carrying supplies between camps. Horses can use snowshoes quite successfully in deep snow, and here they certainly have an advantage over dogs."

Watkins. Labrador. 75.113.

"The propeller-sledges were constructed in Finland. They were propelled by an aeroplane motor of 120 h.p. In the second year of our expedition they succeeded in travelling as far as Eismitte. They had a speed of 40 km. an hour.

The chief drawbacks for the propeller-sledges are that it is very difficult and takes much time to bring them and their fuel up to the inland ice; that they cannot travel in snowstorms in conditions when dog-sledges can still travel; that the safety of travelling with dogs is greater than with propeller-sledges on account of the fragility of the motor and the body; and that the propeller-sledges are rather helpless in the regions of the crevasses but work successfully in the interior region. Maybe they will work successfully in the Antarctic." *Sorge. Greenland.* 81.335.

"The most interesting report in the first volume is that by Dipl. Ing. Curt Schif on the motor-sledges, or, more properly, propeller sledges. It was Wegener's conviction, after the many experiments which had been made with tractors in Polar regions, that the load-bearing member should not be identical with the driving member. The driving wheel of a tractor sinks in snow and before long the machine is hopelessly stranded. The propeller sledges had skis and an air-screw driven by a 112-h.p. motor. It was an investigation of some importance to try these contrivances out in Greenland. Any brief summary of the results must admit at the outset that they were worse off than a dog-sledge in crevassed districts, on slopes, in a head wind, or in soft snow. Moreover starting was always difficult, since the skis tended to stick in the snow. In the ideal conditions when they were superior to dog sledges, *i.e.* where there was a hard surface in fine weather on the central part of the inland-ice, they were very much superior. The useful load, apart from the crew of two and their emergency equipment, was then 1200 lb. and a speed of 20–25 miles per hour could be kept up. During such a run they would be using less fuel per unit of useful load than a dog-sledge would use under the same circumstances and travel could be continued during the summer night without tiring the crew overmuch. A further advantage of the fuel-burning sledge is that halts can be made for scientific work without the loss that is incurred by having to feed a dog-team which is not doing any work.

The sledges' real field of usefulness is on the ice beyond the coastal zone of comparatively steep gradients and frequent crevasses. Schif works out a time-table for the combined operations of a motor-sledge and dog teams. He assumes two trips with ten sledges occupying twelve days in which $2\frac{1}{2}$ tons of useful load and $2\frac{1}{2}$ tons of petrol and supplies are brought over the 60-miles'-wide coastal zone. One motor-sledge can now bring the $2\frac{1}{2}$ tons of useful load to a point a further 200 miles inland in the course of a further sixteen days." *Review of Wegener.* 84.518.

SLEDGE BOATS

The Nansen sledge may be converted into a boat in the way first used by Stefansson (picture in 'The Friendly Arctic'). Lash two ration boxes, steadied by battens below, across the box platform about 3 feet from each end of sledge. Lash a narrow plank about 4½ feet long across on top of each box, with blocks screwed to under side near each end. Select two spare Nansen sledge runners or bamboo poles to form the gunwales, to be lashed underneath the cross planks against the blocks.

A stout waterproof canvas skin is made to fit under the sledge, with loops or sleeves along the top to take the gunwales. A Mount Everest carrier or rucksack in the bows and the handle bars in the stern serve to hold the canvas at bow and stern. The gunwales are passed through sleeves or loops in the canvas sides and lashed to the cross planks.

Two ski sticks are lashed to the feet of two sledge columns and the opposite points of the gunwales, with the baskets outboard to serve as outrigged rowlocks, guyed to the gunwale, or the stick will break when rowing strain is brought on it. A pair of skis, lashed to the heads and shafts of two ice-axes, make serviceable oars. Such a sledge boat has been found to carry comfortably three men and 500 lb. of stores across leads in the pack or open water along the shore.

"Travel was by means both of sledge and boat, one of the sledge boats being carried. This being lost in an off-shore storm, a second boat was constructed out of two Li-lo mattresses and planks from an old hut. In it we were able to travel some 80 miles, on one occasion taking six dogs as well as some 300 lbs. of equipment." *Glen. North East Land.* 90.301.

SLEDGING WITH DOGS

The following notes are condensed from an article written for the *Polar Record* by Mr. Andrew Croft after his return from the North East Land Expedition of 1935–36:

The Cape York district produces the best dogs owing to walrus food available there. But the dogs reared at Jacobshavn are little inferior and get excellent training in the rough ice of the fjord carrying heavy loads from the halibut fishing. Watkins, Lindsay, and Glen got all their dogs from this district; Rymill many of his.

The Greenland husky looks like a cross between an Alsatian and a Chow, but may be of any colour. Most of the best weigh from 70 to 80 lb., but a few owners who have improved their strain by avoiding inbreeding produce dogs up to over 100 lb. There is a fair supply at about 30*s*. per dog. Except at unnecessarily high cost it is rarely possible to buy more than five or six dogs of the same family. These

families can form the nucleus of each team, completed by buying from other owners. Long-legged dogs can pull better in deep snow, but short-legged dogs often pull more steadily. No great advantage in either type provided the dog is big with a good forward stance, showing that the pulling muscles of his chest are well developed. Excellent pullers may be fighters sold because they are a public danger in the district. If possible see the dogs at work in teams before purchase. Age two to four years is best but many five-year-old dogs still good. Examine the dogs' teeth before purchasing.

DRIVING

Teams may be driven in tandem, centre-trace, and fan formation. The first two are used in Arctic Canada, through woods and deep snow; useful generally in picking routes through bad pack-ice. On a centre trace it is difficult to prevent the dogs idling; if the hinder ones see the whip circling in front of them they cower and lose enthusiasm for their work, of course unless there is a very good leading dog. Each dog has little freedom of movement, being attached by a cord only 20 inches or so from the central trace.

Greenland Eskimo always drive their dogs in fan formation, and this should be taken as the standard. The dogs are all abreast obviously enjoying themselves. Any tendency to slack can easily be discouraged by the whip. Each team should include one bitch, it makes much difference in the spirit of the dogs. The king dog and the next strongest will place themselves on each side of the bitch and the other dogs show a preference for one flank or another. The wings are key positions because many dogs object to sledging without a companion on each side. Do not start until these important dogs are in their right places. Discourage tendency to change by the whip. If wing dogs start running inwards traces soon become badly tangled. It is the only real disadvantage of the fan formation, but usually the driver's fault if it is frequent.

On a steep descent the dogs can act as brakes. The driver whistles to the team, who slow down and divide half on each side of the sledge, which then runs over the traces and gets ahead of the dogs. The driver pulls the handle bars back, tipping the sledge, and lets his feet drag in the snow between the rear ends of the runners. Meanwhile the loaded sledge is dragging the dogs downhill. On rocky ground lift the traces over the handle bars.

To cross a channel, tide crack, or crevasse up to about 6 feet wide the driver leans forward and pulls the dog traces in towards him as he sits on the sledge. When the dogs reach the impediment and are all in a line on the edge of the ice, the driver lets go of the traces, the dogs

all jump across together, and reaching the other side pull the sledge after them.

When loose, huskies usually go about in teams or families under the lead of the oldest, wisest, or strongest dog, known as the king dog, who keeps order in the family. Every dog in a team knows his own social position. If a king dog cannot assert his authority over a scratch team shut him up with each dog in turn, so that when they are all together again every dog admits his leadership. Fighting between members of a family is rare, but teams are usually at daggers drawn. To stop a wholesale fight take a running jump into the mass of dogs, who immediately disperse.

A driver must command the respect of his team by strict discipline, being as fair as possible to each dog, feeding them well, and looking after their needs. They respond to affection and never bite you except when frightened. A really good driver who has trained his dogs since they were puppies hardly uses the whip, except for steering. To turn right he lashes the snow to the left and cries ILLE; to turn left the command is YUK. Never talk to a companion while sledging: it disturbs the dogs. Keep them moving at a fast trot, but discourage galloping, which wears them out.

In very severe climates such as North East Land, build houses for the dogs to protect them from the winter gales; it keeps them in better condition than if they were unprotected and prevents them running after bear or reindeer.

FOOD

In cold weather at the base when there is plenty of fresh food available, dogs should have at least 6 lb. daily: seal, walrus, bear, white whale, and fish of all sorts. If the fish is frozen or salt give blubber to aid digestion. During the spring and summer cut meat and fish into strips to dry in the sun for use on shorter sledge journeys or laying depots for longer. Dried fish and meat weigh about half a similar amount of fresh food and are almost equally nourishing. It is highly important to feed the dogs as scientifically as possible with plenty of variation and fresh food so long as they are at the base to prepare them for long journeys when each receives only 1 lb. of dog pemmican daily. This does not really satisfy a dog on a long expedition, but no better compressed food has yet been found. Cakes of whale-meat meal and blubber have been suggested. They would certainly cost only about a third of dog pemmican, but it is doubtful if the food value is as good.

On a long journey such as across the Greenland Ice-cap it is impossible to lay out depots in advance or to have supporting parties. Two-thirds of the weight on the sledges will be dog food, and this does

not provide for much more than fifty days. For longer journeys there is no alternative to sacrificing some dogs to feed the others. It is a dismal expedient which should be adopted only when there is absolutely no other course possible.

HARNESS

In Greenland seal skin is used for harness and traces, but is soon eaten by dogs on a really long journey. Best material for harness is double stout canvas sewn together in strips rather more than an inch broad. The cross piece for the check should lie just below the dog's windpipe and the rear ends of the harness to which the harness rope is attached should be in the small of the back. Harness must fit and at least three sizes should be made. Cut the harness rope about a foot long, more or less, so that each harness plus rope is the same length for all. Make traces of smooth three-ply rope about $^3/_{16}$ths of an inch in diameter, steeped in a tar solution beforehand to make it less eatable. Traces for a team are all equal in length, varying according to the number of the team but not less than 14 nor more than 20 feet. Splice a small wooden toggle at the end of the trace to go in a tight-fitting back splice on the end of the harness rope. This can be loosened at a moment's notice. Tie a knot at the other end of the trace; collect all traces in a bunch and put them through the hitch in the middle of the forearm of the sledge, lashing them in a bunch so that they will not pull through.

For summer sledging over sharp ice-crystals fit the dogs with boots made of rough canvas or well-oiled leather, each cut to the shape of a dog's foot, the upper part sewn on to a soft tweed or blanket material with cotton cord threaded through the two seams in the cloth upper so that the boot can be tied fairly tight round the dog's leg. Boots must be taken off at night time.

Dog whips are best made of white-whale skin with lash about 8 feet longer than the dogs' traces; the raw hide tapered to a point to which a narrow whip end about 2 feet long is attached also made of whale. Bind the broad end of the tapered lash rigidly to the whip handle about 1 or 2 feet long. If no good raw hide available use varying thicknesses of rope which is better than inferior skin.

Although harness may be soaked in paraffin and the traces in tar, the dogs on a long sledge journey will eat up everything, not because they are hungry, but merely owing to boredom on enforced lying-up days. The only way to prevent this is to break the dog's back teeth from both sides of the bottom jaw: a hateful operation of which details are given in the *Polar Record*. It sounds brutal, but is the only remedy against endangering the safety of the whole party.

A sledge wheel is essential and the cyclometer type too fragile for dog sledging. Professor Ahlmann had a good sledge wheel which drove the counting mechanism by a worm wheel. This worked excellently in snow.

Andrew Croft.

On the British Graham Land Expedition, 1934–37, Surgeon Lieut.-Com. E. W. Bingham, R.N., was in charge of dogs and sledging equipment, and a detailed report will be housed at the Scott Polar Research Institute, with specimens of harnesses, traces, whips, sledges, etc. Dogs are wonderfully adapted for all Antarctic conditions and, apart from actual rock climbing, can go anywhere where men can go.

Bingham spent time and patience in mating the bitches and rearing fine, healthy puppies, increasing our pack from the original 45 to 98.

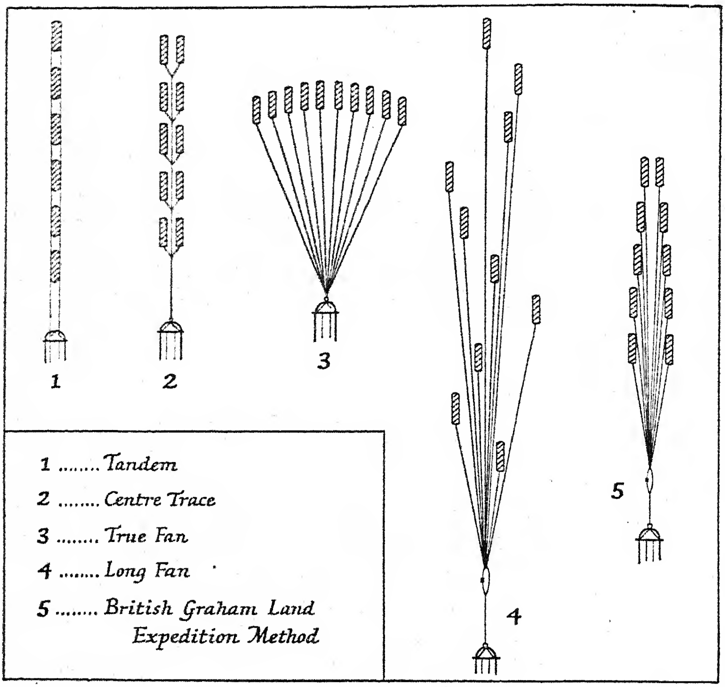
We went prepared to adopt any method except tandem, which is good only in thickly wooded country. Centre trace was ruled out, as dangerous on thin ice and among crevasses. For if a team falls through, the dogs are restricted by their short traces, and become entangled while trying to swim; if one breaks through, the one behind is dragged into the same hole as his trace is too short to let him run round it. On snow-bridges over crevasses if the leading dogs break through their weight on the centre trace will pull the rest down. To cross small open leads in sea-ice or open tide cracks, the dogs bunch together before jumping and a centre trace becomes tangled, causing them to miss their jump.

The true fan is unpractical in Graham Land, for as each dog must make his own trail, it is to be used only on hard surfaces. Over hummocky and broken sea-ice the dogs could run only two abreast; so we came down to the long fan mainly used in Labrador: the dogs on separate traces, varying by about 6 feet; when the surface is heavy they can fall into single file. But we had to consider the dogs losing heart and becoming lethargic on long journeys. Huskies need companionship to keep up their spirits, so we modified the long fan and drove our dogs on separate traces but pulling in pairs, with one or two leaders according to taste. To a 6-foot leading trace the individual traces were fastened; the first pair were on 12-foot traces, 18 feet from the sledge, giving the driver room for manoeuvring. The other pairs were spaced out at intervals of 6 feet, which put the leading pair in a ten-dog team 42 feet from the sledge. We found this system well adapted to Graham Land conditions and well received by the dogs.

We went equipped with webbing, canvas, lamp-wick, and rope for making harnesses, and various types of cord, log-line, and rope for traces; harnesses of 1½ inch double lamp-wick stood out as much the best. Webbing was good but cracked in really cold weather if damp.

The harnesses were Labrador pattern, but instead of a cross-piece on the chest the two loops were crossed over, making a very neat harness, but needed careful fitting to each individual dog.

For traces $1\frac{1}{4}$-inch tarred hemp was much easier to untangle in cold weather than manilla rope and its condition much better when wet; plaited cords all tended to break when wet and frozen.



1 .... *Tandem*

2 .... *Centre Trace*

3 .... *True Fan*

4 .... *Long Fan*

5 .... *British Graham Land Expedition Method*

It was essential to have a sledge strong enough to carry a load over sea-ice, yet light enough to be carried by one man in ice-falls or on rocky mountain sides. We arrived at a good general-purpose sledge, weighing about 65 lb. when fitted with handlebars, and the brake in general use in the Central and Western Arctic.

On shelf-ice or inland where no fresh food could be had, our teams of ten dogs each could stay out unsupported for fifty-six days on full

rations, 1 lb. of Bovril pemmican a day for each dog, and occasionally a small piece of blubber or an Adexolin capsule (vitamins A and D) put up by Messrs. Glaxo, Ltd. On this our dogs kept fit and strong in journeys up to eighty-four days.

Summarized from paper by J. S. Rymill in the Polar Record.

". . . compared with the 12 miles per day of man-hauling the advantages are obvious, especially since the men will not be tired out at the end of a day's journey, and both the dogs and men will come back perfectly fit after a six weeks' journey. Every man on a sledge journey should know how to drive dogs, since it is a great mistake to have to rely on dog drivers. The average man can learn to drive dogs quite successfully in a few months, and he will soon know how to get the best out of his team. A good team driven by a good driver on hard snow with a light load can do as much as 100 miles in one day.

Any one who has used sledge dogs for any length of time and has travelled with them in difficult country will agree that for a long journey there is no better method. A team should consist of seven two-year-old dogs of the same litter, led by their mother. These dogs may be driven in three ways: in the fan method, or in pairs on a single trace, or in single file. In the fan method each dog is on a separate trace, and they spread out in the shape of a fan in front of the sledge. This is the safest way on thin sea-ice, since the dogs are spread out widely and there is little danger of their all going through at the same time. On the other hand, there are three great disadvantages to this method. Firstly, the enormous weight of the seven different traces; secondly, the dogs are always getting their traces twisted up, so that as a general rule it is necessary to stop once every hour to unwind them; thirdly, the dogs at each side of the fan are not getting a direct pull on the sledge, and thus a great deal of energy is being wasted. In normal conditions the best method of driving is in pairs on a single trace. If however the snow is very soft and deep, it is better to use the single-file method." *Watkins. Labrador.* 75.113.

"Huskies will keep on pulling indefinitely as long as they can move the sledge, but as soon as it sticks they will be down, or leap forward spasmodically, and it takes a good driver to get them all straining together at the precise moment when he manages to heave the front of the sledge over the obstacle.

Dogs are never content to pull for long in one position, but must start jumping over the traces to right or left and then dodging under or jumping back again until at last one has to stop, loosen out the traces from the sledge and untangle them from that end." *J. M. Scott. Labrador.* 157.

"We had not yet had time to train the dogs to single-trace driving, so that we were driving them in Eskimo or fan method. Each dog has a separate trace and they spread out in a fan. Although this method is good on hard sea-ice, it is useless on soft snow, as each dog has to make his own track. On single-trace driving the front dogs make the track and the rest can get a good pull. Owing to the soft snow and fan driving we could do only short distances each day." *Watkins. B.A.A.R.E.* 79.360.

"We experienced great difficulty in persuading the dogs to wade or swim the streams. They would cower shivering on the banks until one less timid than the rest could be induced to lead the way.

The dogs had by now been working for six severe weeks, and having covered 250 miles without seeing anything ahead but a desolate waste of snow, they were somewhat listless. Their state of mind was each day reflected in the mileage. We considered increasing our sledging hours in order to maintain the pace, but it is doubtful whether this would actually have been possible. Indeed, considering the condition of the party in a later stage of the journey, it would possibly have been wiser to have slightly reduced them. We travelled for nine hours daily, but with striking and pitching camp and cooking we were working for all of a sixteen-hour day.

Our greatest problem at this time was to get the leading team to pull hard with nothing to interest them ahead." *Lindsay. Greenland.* 85.398, 99.

"For the monotony of an Ice-cap journey West Greenland dogs are probably the best in the world. They are not so intelligent as Canadian and Labrador dogs, and therefore do not require so many interests to keep up their spirits. Jakobshavn and Cape York have much the best dogs, as only in those two places is dog food abundant. The Jakobshavn dogs are trained to severe cold, since very low temperatures are experienced each winter at the halibut-fishing camps, and Jakobshavn is the best place to learn dog-driving.

There is no difficulty in driving trained teams 300 or 400 miles over the Ice-cap in a journey lasting three or four weeks. But after that, when the dogs have lost interest and their only desire is for fresh surroundings and more food, then it is that the experienced dog-driver comes into his own. The second and subsequent teams will always follow the leading sledge; the difficulty, and it is a very real difficulty, is to get the front team to pull ahead. This can be overcome for a time if there is a spare man to ski in front but, after this device has lost its novelty if the party does not include one expert to drive the leading team, the dogs will have their own way and transport arrangements collapse." *Lindsay. Greenland.* 86.247.

"Both Iviliks and Baffinlanders drive their dogs in a fan with traces of varying length. The leader is always well clear of the second dog to allow him to turn without hindrance. To turn them to the left the driver says *Aouk*; to the right *Huhk Ehk*; and to stop *Wuu*. To make them lie down the whip is gently thrown out over their backs. To start, the sledge is tapped with the whip or foot, while the driver may say *Heh*; with a heavy load, especially in cold weather, it may be necessary to pull back on the bridle, let go with a jerk, and at the same time pull the sledge sideways."

Manning. Southampton Island. 88.233.

"For traces, Messrs. British Ropes supplied a 1-inch tarred rope, which was found to be very suitable for all conditions. It is unnecessarily expensive and also impracticable to use a wire-centred rope, as a tarred substitute is just as good, especially if the dogs' teeth are broken."

Glen. North East Land. 90.194.

"The ideal food for a dog team is fresh seal meat and fat, so that for coastal ourneys where it is possible to find seals, it is unnecessary to take any food, either for men or dogs. This means a very light load, so that long distances can be covered. On an inland journey where no fresh meat is available, the best food is Bovril Dog Pemmican. Each dog will require 1 lb. of the

pemmican every day. It is an extremely good thing to take some seal fat as well, so that the dogs can have a very small piece with their pemmican."

Watkins. Labrador. 75.113.

"The sledging rations for the dogs consisted of a pound of Bovril dog pemmican and a quarter of a pound of Maypole dog fat per dog per day. On the longest journeys in cold weather the dogs kept perfectly fit on these rations. On summer journeys the extra fat is not necessary."

Watkins. B.A.A.R.E. 79.493.

"We started the Ice-cap crossing (from a point 3870 feet above sea-level and about 12 miles from the edge of the Ice-cap) with thirty-seven dogs of which twelve were taken through to the end of the journey. The number was gradually reduced as the loads became lighter, the dogs in the worst conditions being killed and fed to the others. It is necessary to kill dogs on such a journey as a large number is needed at the start when the sledges are heavy, and it is not possible to carry food for so many all the way. The surviving dogs benefit enormously by a periodical return to fresh meat, and could not be maintained in good condition for anything like so long if fed only on pemmican. If the dogs are fed till the moment that they are killed and are then shot with a humane-killer they experience no suffering, and indeed come to a more merciful end than if they had been left with the Greenlanders." *Lindsay. Greenland.* 86.247.

"Considerable reliance had been placed on fresh meat as a source of food supply for the dogs. This was due entirely to financial considerations. Hunting during the first summer however had been made impossible except on a few isolated occasions due to other work on hand, and gales during the autumn further complicated the situation. It was not until late in the spring that the seals began to lie out on the ice, and even at the beginning of April they were still so shy as to make stalking extremely difficult. With the return of warm weather conditions became much simpler. When stalking, white screens were used, but it was generally found simpler and better to use Stefannson's method of feigning to be a seal oneself. ·303 magazine rifles, of the ordinary Service type, were mainly used, and were found excellent. A high-velocity rifle is essential, and it would be difficult to suggest anything more suited than a ·303 for general use, although a light automatic ·22 is very useful for seal hunting." *Glen. North East Land.* 90.214.

"The ground, littered by boulders, was also cut up by deep stream beds. Two cartwheels had been bought in Tromsö with the intention of making some sort of cart for use over surfaces of this nature. They were not nearly strong enough however and after the first attempt the cart was smashed to pieces. From then onwards Eskimo rigid sledges had to be used. These, fitted with steel runners, are very strong but correspondingly heavy. Huskies love normal travelling, but stopping every moment with a jerk and progressing again at a crawl is purgatory to them. For crossing such ground, motor bicycle wheels with pneumatic tyres ought to be taken so that they can be fitted to the sides of sledges, thereby giving a perfect transport method, much used by some of the Norwegian hunters in East Spitsbergen."

Glen. North East Land. 90.207.

CAMELS

We cannot deal with the differences between the camels of Central Asia, of Arabia, of North Africa, of India, and of Australia. For full information on breeds, types, management, and diseases refer to manuals of the British and French Armies and to veterinary handbooks. But we must consider briefly the respective qualities of riding and baggage camels; the equipment and saddlery; the load, speed, and range; the care and management of grazing and watering; the merits and defects of travelling with camels in milk. The general account of camel transport is contributed by Mr. Francis Rodd. The quotations from the *Geographical Journal* which follow will direct the aspiring traveller to the papers in which one may learn more of the possibilities, pleasures, and defects of desert travel by camel, with some indication of the precautions and the qualities required for success.

Camels, if of the right breed, are very good on rock and in mountainous country; they are as agile and as steady as mules. But if they are plain- or sand-bred camels and not used to rock they cut their feet, fall and break their bones. No African or Arabian camels can stand mud. They slip, split their breast bones, and break up. Camels can however stand a lot of cold with impunity if it is dry; a lot of wet weather is bad even if the climate is warm.

A camel's condition is recognized by the firmness, and in some races by the size of the hump, by the fullness of the quarters and the solidness, as opposed to the scragginess, of the neck. The camel can do without water for days but not without food; moreover he is a fastidious feeder. Some, but not all, camels eat grain; when they are not used to it and there is no other fodder, a mash or porridge of soaked and pounded grain is a good way of giving it as it can be poured down the animal's throat out of a skin. Dry straw is better than no food; the animal must have something on which to chew the cud. When animals are exhausted by hard marching and the choice comes of an extra day without water or a stop for pasture, choose always the latter. In cold weather, and especially when green food is available, camels can work, *i.e.* march loaded, for ten to fourteen days without wanting to drink. In hot weather camels should drink every fourth day for the sake of condition. When the weather or work is very tiring every third day is not too frequent for water unless a long waterless journey is contemplated, when they should be worked up to the maximum, gradually if possible. Before a long crossing between watering points keep

camels away from water so that when they are watered before starting they drink until they cannot put another pint inside them.

Camels are delicate. They require constant care. Always take the advice of your camel man about food, water, and conditions. This is a hard rule because, unless the traveller has very reliable men or much personal experience, he is liable to be put upon. Disregard of advice however may lead to the loss of camels or the breakdown of the expedition. It is a difficult problem and bound up with the question of whether camels should be hired or bought by the traveller. If he has experience of camels and desert travel generally I would not hesitate to advise purchase. However bad the price on re-sale may be, purchase is nearly always cheaper than hire. On the other hand, unless the traveller has good men with him as well as personal knowledge of camels his beasts may be badly looked after, deteriorate and even die wholesale in conditions where hired camels would survive. Let it be a good rule, where the traveller owns his own camels or any other sort of animal transport, always to attend when the beasts are being watered and to go the rounds frequently to deal with sores, sickness, etc. For primitive veterinary attention, permanganate and corrosive sublimate are the best disinfectants. With plenty of tow or the equivalent, a pair of strong surgical scissors and a surgical knife, wonders can be done. For diseases it is probably best, unless the traveller has some experience or veterinary training, to follow native advice. Even the most apparently curious native remedies have something in them. It is mainly on disinfectants that they are inclined to be weak and unbelieving.

RIDING SADDLES

Of riding saddles there are two sorts, the sort where the rider sits on a hump in a cradle or seat and the sort where a rider sits on a seat on the withers. The former are heavier, softer, and probably easier to ride on; the latter are lighter, more restful, but more difficult at first to sit. The sorts are the subject of much dispute between Europeans and natives. No advice can be given; experience alone can give the traveller judgment. The camel is steered with the feet, sometimes in conjunction with a stick for tapping him on the shoulders, and with a single bridle, either in the form of line attached to a nose ring or nose peg or in the form of a rope attached to head collar or halter. No camel can be properly ridden in boots; where the saddle is on the withers the rider's feet are on the camel's neck and a prehensile toe is desirable to grasp the cords of the neck. When the rider's seat is on the hump his legs are crossed on the shoulders in front of the withers;

in either event steering the camel is carried out as in horsemanship by appropriate "aids" applied with legs or feet.

The strength of a camel is in his fore limbs. His quarters are weak. The breast pad on which the sitting camel rests and bears his load is, roughly speaking, under the withers. The camel's load is carried forward. Where there are two girths, of the two baggage load lines the forward ones in each case do the work; the hinder ones are for balance and steadiness.

PACK SADDLES

The best type is probably the one which the local native knows best, can make and can mend. For large expeditions a local factory can be set up and perhaps some improvements effected on the local type in the way of strengthening, ironwork, etc. For ordinary or small expeditions the best native pack saddle is better than the European and nearly always lighter; moreover the native can mend it but cannot do much with the European sorts. But of types of saddle this is no place to advise, since they vary from place to place and are a very provocative subject among travellers. Every race of camel man has a different type of saddle and method of loading.

ROPE

Native rope is usually pretty bad unless made of certain sorts of date-palm fibre. European rope, plaited not twisted, in ample supply may be a luxury but is also a solace to the traveller and his temper. Nevertheless, it is expensive, not essential, and needs careful watching, since in a large caravan it tends to evaporate. Nearly everywhere the native camel driver, whether hired with his camels or by the traveller to look after the traveller's camels, is supposed to make or provide his own rope wherever material is available, though the owner may have to buy the raw material. Throughout equatorial Africa the Kabba-hyphene-dûm-thebaica-palm provides the raw material gratis. In these areas the camel man is supposed to spend his spare time making rope. But the traveller is sure to traverse areas where no rope can be made, for lack of material, and for these areas European rope—even if only a reserve supply—is invaluable since the local native rope wears quickly. A good rope for wells is also invaluable; there is nothing more depressing than hearing the only frayed and knotted native well-rope part near the top and fall into the water with the bucket attached.

LOADS

In desert travel packages must be of sufficient size. For porters, packages exceeding 50 lb. in weight are inconvenient, tiring, and in

many countries prohibited: a parcel of 100 lb. or more becomes almost unmanageable. But for camel work the weight of packages should for choice be of about 100 lb. in weight and of convenient size. A camel's load varies between 250 lb. and 600 lb. for some exceptionally sturdy races. In the absence of reliable data the traveller should not reckon on more than 300 lb. per camel. Nearly all camels can carry more than 300 lb., certainly, but by the time water, a camel driver, and all the spare items, which the traveller has accumulated but forgotten to account for, are loaded, the weights will probably be fully up to the limit. A camel can be overloaded for a few days but not for a few months or even a few weeks on end. The same applies to donkeys, mules, horses, men, yaks, llamas, and, I expect, elephants. It certainly also applies to motor cars.

A suitable camel load consists of two 100-lb. cases with two water skins slung one below each case. A good camel can also carry a driver on top of this load for part of the day. The loads are slung with two rope slings connecting the cases. The forward sling is tight and the forward ends of the cases are carried higher than the hinder ends. Rope camel nets should be provided for small packages. They are also good for misshapen round packages and bedding.

STAGES

The question of hobbling, grazing, roping or not roping camels and other transport animals varies so much from place to place and with the marching timetable that no rules can be laid down. The problem has no ideal solution; every compromise depends on actual circumstances. I have always preferred one long march to two stages a day, but then I do not much mind the strong sun of African noonday. Most African travellers seem to prefer the two-stage system, which however means more fatigue for native and camel and, generally speaking, undernourishment for the camels as well, since they will not eat under the blazing midday sun or immediately after tiring marches. I prefer the very early start before dawn and a march of up to ten to fourteen hours and then a rest in the late afternoon and night. The camels get in some grazing in the cool evening and usually also a little more for an hour or so before starting. *Francis Rodd.*

"The average Badu has ten to fifteen or twenty grazing camels (*bosh* as distinct from *rikab* or riding camels)—a shaikh perhaps fifty. In summer they stay close to waterholes, watering every second day, or if rain is about may remain five days absent. In a good winter with rains and consequent pasture, an unusual situation, they may wander for two months from their accustomed waterholes—man depending upon camels' milk for his sustenance, but normally they must water their milch camels every ten days or so.

The sands know two saddles. The double-poled saddle which is placed over the camel's hump, *shadad*, the normal saddle of much of the rest of Arabia, is used only by the Murra, the Sa'ar and Karab. By the entire remaining tribes, as indeed in Oman and throughout the whole of South-Eastern Arabia, the *zana* is used, a small light framework (without poles) straddled with saddle bags and covered by a goat skin. This is placed behind the hump, where the Badu invariably rides, normally in a kneeling position with his feet tucked up under his haunches. To stand long distances, as for raiding, to carry his master and a ten-days' water supply for him, and to survive long and hungry marches, the camel has to be fattened up beforehand. The Badu travelling light lives on a pancake of unleavened bread only, and the doubtful fruits of the chase." *Thomas. Rub' al Khali.* 77.21.

"Our party . . . consisted in all of nineteen persons and thirty-two camels in the very pink of condition, as they well needed to be for the task that lay before them. With only a few exceptions all our animals were of the 'Umaniya race, the best of all Arabian camel strains; and furthermore they were all what are known as Ramliyat or sand-bred camels as opposed to those of the steppe-desert, which indeed have many virtues but are as little at home in a region of eternal sand as our own animals ultimately proved to be on the steppe and rock into which in due course we passed on the conclusion of the main part of our programme. It was then something of a revelation to see how gingerly they trod on the hot sharp gravel and rock of the western steppes, on which the bare-footed Arabs of our party would walk and run with complete unconcern while my own tender feet were full of practical sympathy with the camels. Never before had I had an opportunity of observing Arabian camels under such a searching test of their reputed merit and powers of endurance as that provided by the ninety days of our wanderings across Arabia by way of the Rub' al Khali. Two of them we slew and ate in due course, while another we abandoned in the middle of the desert when it went irretrievably lame. Of the remaining twenty-nine we sent back fourteen with eight of our men and the heavy baggage by the easiest route to Riyadh after two months of wanderings, and they duly arrived safely at their destination about a fortnight later. The remaining fifteen, specially selected for the crossing of the waterless desert, together with eleven of us and a Saluqi hound picked up by us at Jabrin, saw the whole thing through from beginning to end. They were a sorry sight indeed on arrival at Mecca on the ninetieth day, thin and humpless and mangy. But they had done their job, and done it magnificently under conditions of drought and short commons such as only the best camels of Arabia could stand. They had vindicated a much-vaunted but seldom-tested reputation, and on some of those ninety days they stood up to hard merciless driving in a way which I should never have thought possible. It is difficult to feel any sort of affection for the camel, but admiration is the least due of those animals to which in so large measure we owed the successful issue of our venture. On one occasion they went for over forty-eight hours without a morsel of any kind of food, and ten days without water was the record of the best of them in the third month of our wanderings, during which in all they covered 1800 miles in ninety days—surely a magnificent marching record." *Philby. Rub' al Khali.* 81.3.

Specimen contract for the hire of camels for a journey down the Wadi Maseila:

"PRAISE BE TO GOD.

Seiyid 'Abdur Rahman bin Sheikh al Kaf has taken thirteen camels on hire to Seihut from Ma'tuf bin Khashash, Muhammad Faraj, and Karama bin 'Abdul Sheikh, for Mr. Ingrams, his wife and party, at $20 per camel, *i.e.* in all $260, out of which the sum of $115 (in cash) has been paid to them, and they have also been given a draft for $80 on Seiyid 'Abdulla bin 'Aidarus al Hamid of Seihut, leaving a balance of $65 due to them which shall remain with Seiyid 'Abdur Rahman until their return (to him) and will be paid to them if they make neither trouble nor mischief. The condition being that the journey shall be for a period of ten days from Tarim to Seihut commencing from Thursday, the 28th Sha'ban 1353.

Out of the thirteen camels eight are for luggage and five for riding.

This was done in the presence of the following witnesses on the 28th Sha'ban 1353.

Witnesses Karama Bin 'Abdul Sheikh
Ma'tuf bin Khashash
Muhammad Faraj

"We have used camel transport only, and have found it in every way preferable for our purpose to the motor trucks used in Faiyum. It takes one slowly but surely to the exact spot, and by the exact route, one wishes, permits of fixed camps in places absolutely inaccessible to any car yet made, and provides on its stately march opportunities to examine in continuous unhurried detail the terrain traversed. It is certain that the prehistoric sites found on the Libyan Plateau, during our six days' march to Kharga from the Nile Valley, would have escaped notice had not one of us, generally both, continually been scouting on the flanks of a slowly moving caravan. We were relieved also of the anxiety of dependence on cars for our water supply, while camping on the eastern scarp far from springs." *Caton Thompson.* 80.370.

"But *badawin* usually have a very definite idea of the duration of a normal day's journey, so in extracting information from them this can be utilized by using such expressions as 'a rather long day,' 'a long day,' 'a very long one,' 'a very long one indeed,' which would differ from each other by about 2 miles, a rather long day being from 26–27 miles, a long one, 28 or 29 miles, and so on.

In addition to the day's march by caravan, two other units are occasionally used. The first is a forced march. When *badawin* get into difficulties in the desert, say by running short of water, they fling all the baggage from their camels on the ground, where no other desert men would dream of touching it. Then, leaving it to be recovered at some more convenient time, they load only their water-skins and a little food on their camels and march almost continuously day and night, with an occasional ride on their beasts to rest themselves, and a halt of perhaps an hour or so at sunset to take a meal, or if it be in the hot season, in the afternoon to rest their beasts. They cover the ground very rapidly, and in this way even a baggage caravan will march 45 or even 50 miles a day, without much difficulty, though of course this pace can only be kept up for two or three days. The second kind of day's march that has

to be considered is that by *hagin*, or riding camel. But the length of this journey varies so enormously according to the capacity of the rider and his camel that information given in these terms is of little value. Its average length is perhaps 30 to 35 miles in parts like the Libyan desert, where the *hagin* is only a picked baggage camel; but it may be anything between 25 miles and double, treble or, in very exceptional cases, four times that amount, if he comes from a special riding strain."

Harding King. Libyan Desert. 77.545.

"If the object be purely to cross a waste, then the slowness of the camel is simply a disadvantage. The only exception is when the waste is one of sand-dunes lying at right angles to the line of march; but with the adoption of 12-inch and even larger diameter tyres it is doubtful whether this still holds good. But if the object is to search for something in the wilderness, and, stunts apart, this will generally be the case in serious enterprises, the question must be reviewed in the light of the conditions, and the verdict may well be given in favour of camel transport. Take, for example, the search for artefacts in the Libyan desert. A man in a car will never see an artefact while driving, which means that he must stop and get out to look. A further point in favour of camels is the sense of unlimited leisure which they impart to the undertaking. No schedule need be adhered to, no time-table observed. Distances are measured in days instead of in miles; and the effect of all this on the mind of the traveller is to make him less hurried and more deliberate. As he trudges slowly through the sand his mind chews the cud of his observations, untroubled by the adventurous progress of the internal combustion engine.

Camels vary enormously in capacity, and what is true of one breed will not be so for another. For example, whereas Bertram Thomas and Philby appear to have relied entirely on sporadic grazing for the support of their animals, which were the property of the Arabs who accompanied them, the camels which for centuries have been used to cross the pastureless wastes of the sand sea are accustomed to carry their food on their backs.

For travel in the Northern Libyan Desert two types of camel are available: the Maghrabi, and the Egyptian hill camel. The latter is a poor substitute for the former, with which the Senussi were formerly wont to make their astonishing journeys, but which will generally prove unobtainable for the chance traveller. It is impossible to buy a camel to-day and embark on a journey to-morrow. A long period of training must precede effort, and months will generally be required to collect and harden the animals if the best results are to be obtained.

The Senussi Maghrabi is credibly reported to be capable of 30 miles a day over bad going up to an easy maximum of fifteen days without water or grazing, in cold weather. Naturally some kind of forage has to be carried, and the Senussi use dates and a small quantity of *tibn*, or chopped straw. This performance is, so far as I am aware, unequalled by that of any other known breed of camel. With the extermination of the Senussi the breed of camel used by them for their desert journeys has nearly ceased to exist, and I found it impossible to obtain one, even with months of notice.

The Egyptian hill camel, with which my contractor provided me, is a

small wiry animal used for porterage between the western oases and the Nile. When loaded, ten waterless days at 20 miles a day would appear to be an easy limit of endurance, after suitable training. A caravan of these animals would thus be quite capable of the journey from Bir Mungar to Kufra, if a few gallons of water were carried for a partial relief of thirst. But, were I to undertake a journey in these sands again, I would secure the Maghrabi breed or none at all. With them my radius of action would be doubled, my security trebled.

Desert breeds of camel will not carry loads of much over 250 lb. without taxing their strength. I think that wherever camels are used it will be found that their owners prefer to march by night and rest by day. The march is usually divided into two *shids* or periods; the first from about one hour before sunset to perhaps three hours after; the second from some four hours before dawn to one hour after. When grazing is available this programme should be modified to allow the animals to feed at sunset and sunrise. In this connection it is interesting to note the difficulty experienced by Philby in inducing his Arabs to march by day instead of by night, in order that he might see the country traversed.

The reason for this predilection is sound, as one would expect, being due simply to the bad effects of the sun by day. But in cold weather this is less applicable, and marching by day is attended with little risk. I did nine-tenths of my marching by day, and I did not unsaddle from dawn to dusk; a procedure which would scandalize the military expert of the camel corps. But nearly all such rules depend for their validity on the condition of the animal. Once get your beasts thoroughly hardened and you can ride roughshod over most of them. Government beasts are necessarily fat and scarcely ever hard, and must be treated accordingly.

The question of pack-saddles caused me some solicitude, which the event proved superfluous, as the *baladi* (native) saddles provided by the contractor —rude structures of wood and straw—proved perfectly adequate. The desiderata for pack-saddles, whether for camels or other animals, are three in number, and, generally speaking, are much better met by the *baladi* than by the Government variety.

They are as follows: (1) the weight must be borne by those portions of the body most capable of sustaining it, *i.e.* kept off hump, withers, and the ends of the ribs. (2) The bearing surface cannot be too big after the first requirement has been met. (3) The bearing surface must be ventilated if swellings are to be avoided. It is in this last respect that Government pack-saddles fail so lamentably. The heavy, hair-stuffed bids allow of no ventilation of the bearing surface, except through chance shifting of the whole saddle. The straw pads employed by the Arabs, on the other hand, ensure the continual access of air to the surface under pressure, and swellings with them are invariably due to carelessness on the part of the Arab in allowing the wooden structure to bear down on the back.

In the matter of forage, the only rule is to feed whatever the animals are accustomed to eat. Naturally, in the absence of grazing they must be accustomed to a grain ration by a period of training. Camels will eat a surprising variety of food, but care must be exercised in the desert to see that they do not eat what will cause thirst. Philby quotes an example of this on p. 117

of his book. His camels had eaten freely of a saline herb with the result that they were already thirsty thirty-six hours after watering—five days of endurance of thirst thrown away in a single meal."

Orde Wingate. Libyan Desert. 83.282–285.

"The Somali burden camels take a load of about 160 lb. each side. The loads are tied on to the saddle with rope made from a local plant. The saddle is known as a Heriot and consists of several grass mats laid on the camel's back. The whole thing appears to be most unsafe, but the loads usually remain in position. It is the exception for a box to be tied on right side up, so all boxes have to be packed carefully. The camel transport required had all to be hired. The arrangements for this were made for us by the District Commissioner. When the whole Commission was on the move we required about three hundred camels. The bulk of these were not retained, but were discharged on the completion of the move." *Stafford. Somaliland.* 78.105.

"Only one camel refused to go, and that not because of the rocks, but because it imagined it would sink into some rather soft-looking damp sand. As there was no way round this patch the camel had to be left behind, and we never saw it again." *Fuchs. Lake Rudolf.* 86.122.

"In May and June 1930 I was able to go over a good deal of the ground by camel, through the financial assistance of the Council for Scientific and Industrial Research, and the help of the Department of Home Affairs, through whom I obtained the loan of police camels from Alice Springs. The aeroplane is unsurpassed for rapid reconnaissance, but for any detailed work in this country it, the motor car, and the horse must all give way to that most primitive means of transport in the desert, unresponsive, repulsive, slow, safe, and certain—the camel in his natural environment. Time must be measured in days instead of hours, but when studying rocks which have lain there for five hundred million years, one begins to feel that a week one way or the other does not matter so much after all. In this journey of a month I was accompanied by Mr. E. A. Rudd, a geological student from the University, a black boy, and six camels; not that camels are ever much company. Their bells in the still, cool night are the most attractive thing about them."

Madigan. Central Australia. 78.420.

"The modern system of packing and riding has been developed from the style of the Afghans who have taught white men how to handle this beast. For ordinary work on roads or pads the loads may be of equally weighted stacks of cases or bags roped or wired together and simply joined by ropes, so that they hang over either side of the pack-saddle without a girth or stay; but for trekking across unbroken country it is almost essential to have all goods cased in stout boxes wherein they may be carried loose. The battering to which all loads are subjected during a march through scrub quickly smashes the ordinary packing-case and rips open bags of flour, so that heavy losses of precious stores soon occur. The pack-boxes may measure up to 3 feet high, 17 inches wide, and 2 feet long, that is, along the saddle. One-inch tongued and grooved boards may be used, but quite light boxwood, if carefully strengthened by metal strapping, greatly reduce the weight and are strong enough to withstand the severe bumping they get sooner or later when a frightened or unruly camel bucks its load off. These boxes have a horizontal

bar attached to the saddle side of the box for the cross ropes which go over the saddle and so support them when the beast gets up. We carry water in big sheet-metal canteens, shaped to conform to the curve of the saddle, and holding up to 27 gallons apiece, that is, a gross load of some 600 lb.

At the start of a long trip into dry country where it is necessary to reduce the string as low as possible because of the difficulty of finding sufficient water, loads (provided good camels have been obtained) may all be up to 6 cwt. exclusive of the saddle, which can weigh from 60 to 90 lb. This means a heavy lift of 3 cwt., and so big strong men, both black and white, have to be picked for the expedition; only three persons can comfortably get to work on each box. As a rule a riding camel is taken for each white man, and where the party is of three, with two natives as camel boys, the stores and equipment for an eight-months' trip can be carried on nine pack camels, two of which carry water. On the last trip by having one canteen camel and making each riding camel carry a small pair of canteens (8 gallons per pair) we set out for five months with six pack and three riding camels.

It has often been said that the camel never varies the length but only the frequency of his stride in order to increase the pace. As the speed of the string and the time of travel decides the distance for plotting one's position, we took particular notice of this point, and as a result recorded quite contrary figures. Our conclusion is that the camel does not vary its frequency of stride at all, but lengthens or shortens its stride as required. The leading camel was observed each time, at speeds varying from 2·75 m.p.h. to top speed at 3·3 m.p.h. on the road near Alice Springs. At the lower speed the regular one across country, the camel paced 76 strides per minute when a man walking alongside was doing 103; this was over spinifex country than which there can be little more vexed walking. On the clear hard road the camel still did 76 while the man extended to 109. The modern motorist may think it strange.

At times a man with only one or two camels may travel at surprising speed across a dry belt of country, but the fair average distance for a loaded string, having due regard to keeping the camels in good condition during a long trip, saddles in repair, and the whole outfit maintained in proper order, is as near as possible 100 miles per week: that is, 15 to 17 miles per day across country for six days. On roads this is easily increased to 25 miles per day, or 150 miles per week." *Terry. Central Australia.* 84.499–501.

"They had been stampeded the evening before, and had been lost all night; they might have been lost altogether, had it not been for the skill in tracking of my Mongol companion. Camels that have been badly scared are hard to handle for some days, being subject to fresh panics. We were in a hurry to get them out into 'clean,' open ground, with nothing to scare them. The Mongol and I were each riding one camel and leading another; they were hard to hold, snorting and trembling and shying as they went among the ruins." *Lattimore. Mongolia.* 84.490.

HORSES, DONKEYS, MULES, YAK, SHEEP

The use of these animals for riding and transport varies so much in different parts of the world that the whole ground cannot be

covered. The following notes are mainly on their use in Asia, where they are more or less interchangeable.

In most parts of S.E. and E. Tibet the traveller will have to ride or lose caste, and it is a good plan to take an English saddle: far more comfortable than the native, especially if Army pattern, with a high cantle.

The choice between purchase and hire depends much on local conditions and the season of the year.

"For a journey to Central Asia from Leh, it is always difficult to decide whether to hire or to purchase ponies at Leh. Probably if one is present in Leh after the trading season has begun, after the beginning of July, it is better to buy, but time is always necessary in order to strike bargains. Owing to our very early start, I advanced money to my caravanbashi to buy animals, and ordered him to buy them if possible a month before our arrival at Leh so that they could be well fed before we began to work them. I then intended to hire this transport from him.

This plan was not satisfactory. Most of the ponies were bought a month before our arrival, and when Clifford examined them at Leh at the end of June, they were, with one or two exceptions, a good looking lot of animals. We then found however that the caravanbashi did not wish to take the risk of losing them in the Shaksgam, and being unable to come to reasonable terms of hire, we took them over from him at cost price.

The purchase price of the ponies varied very greatly from Rs. 62/- to Rs. 156/- But the more expensive animals were no fitter for the expedition than the cheaper ones. [21 cost Rs. 1996; 10 died; 11 were sold on return for Rs. 590.]

One caravanbashi (Rs. 50 p. m.) and 7 Muhammadan pony-men (Rs. 25 p. m.) were required for these animals. They were given warm clothing and free rations. Baggage ponies (21), each: barley, 2 seers (4 lb.).

Total rations and fodder required after Panamik, exclusive of requirements for British officers and temporary caravan, weighed approximately 8 tons.

The rate for hire of animals—known as *Res* on the trade-route—is an anna a mile as far as Panamik, and I kept rigidly to this rate to that place. For the large caravan of temporary animals from Panamik to the Shaksgam, which I anticipated would occupy a fortnight's travel each way through desolate and almost grassless country, I fixed a contract rate at Rs. 37/- per animal, inclusive of hire of pony-men. These men had to arrange for their own food and for the extra animals required for the carriage of it. I bought the fodder required for all animals and issued it to the pony-men daily, deducting the cost price from the wages of each man, when he was paid off. Risk of loss was accepted by the owners on these terms, and they were content.

I had considered the possible use of yaks, camels and sheep as transport animals for the expedition. The first are not available for sale early in the year, and probably would not be fit enough. They are of course excellent on snow, but they do not carry loads well in single file or in defiles, and I do not

think they would have been as good as ponies. Camels I could not get, and they would be useless for crossing glaciers. Sheep for transport must be of the right type and very fit at the commencement of a journey. They will only take loads in sacks, and they also are accustomed to travel in herds rather than in single file. They are more suitable for the open plateaus of the Lingzi-thang than for gorge country. Yaks, camels and particularly sheep would however have suffered less from the lack of grass than did our ponies.

If I had the selection of transport for such an expedition again, I should use a temporary caravan of ponies to take me to the Shaksgam, but I should rely entirely on porters for the exploration."

Mason. Shaksgam. Survey of India.

The management of ponies must not be left entirely to the men, of whom one looks after two ponies. One of the party must manage the transport, for the native pays no attention to sore backs and never learns. The original owner of the pony should if possible be engaged as syce. Ponies are generally roped in threes, head to tail. Hobbling at night is usual but seems wrong: perhaps better tied to pegs, but liable to eat through head ropes. Ponies must have grazing, especially when barley is unreliable, containing vetch; bad for horses. Caravan marches perhaps eight hours with one halt, at speed of 2½ miles per hour, maximum load 160 lb. in mountains. Ponies are not suitable for snow passes. They must be led over unladen and local yak or coolies engaged.

"The approach to Mount Everest is over a path passable to mules, donkeys, and yaks. Which of these animals one gets is generally settled by local conditions. The mules are fastest and in good condition can do the average 25 miles of a double stage in a day. Donkeys are not so fast; when they are in good condition a double stage is not beyond their powers, but successive double stages cannot be covered without distressing the animals.

Yaks are strong and reliable, but so slow that there can be no question of double marching." *Spender. M.E.E.* 1935. 88.296.

"Here we transferred all our baggage to the pack ponies. Each of these carried two of the boxes slung on either side of the saddle. One of them carrying our two 11-foot sledges was almost entirely hidden beneath its load, and caused great amusement at the farms we passed on the way. Our cavalcade of ponies was a long one, each animal being tied by a short length of rope to the tail of the one in front. Each man led a string of four to six ponies."

Roberts. Iceland. 81.292.

"Pack donkeys are at best a slow form of transport. In the early part of the dry weather before the grass has been burnt, and paths retrodden, it is most laborious. Furthermore, at least a week is required to get donkeys and men trained and into condition again after the long inactivity of the rains. Ill-balanced loads are scraped off against trees, donkeys wander aimlessly about bare-backed or gallop away in panic with their saddles under their

bellies, native-made saddles give way at unexpected points, and for a day or two all is disorder and exhaustion, with but little progress. The normal load for a donkey is 120 lb., and donkeymen are provided on a scale of five donkeys to each man, with a head man in charge. No head stalls or head ropes are used, and the donkeys directed entirely by voice or by tapping the neck with a stick. On any sort of path in open country they follow well one behind the other, but through pathless grass or forest they become a severe trial to the temper, and many and frequent halts are necessary to enable the scattered column to close up. When the day's march is completed they are turned loose to find what grazing they can. . . . At sunset, after being watered, they are driven into camp, shackled in military fashion to a picket-rope laid down on the ground in a square, and given their ration of durra grain. If either lions or hyenas are in the neighbourhood a fire is maintained throughout the night and extra guards are posted to prevent a stampede. When a donkey hears at close range the lion's roar or the hyena's howl his natural instinct is to break away and run, and if he succeeds he is dead meat very soon afterwards." *Parker. Sudan.* 84.59.

"Donkeys are useful for the men to ride, but not for loads. They cannot go long stages, they are slow, and they drown in the rivers.

Caravans are usually obtainable from one city to another, and certain cities are well-known centres for caravan business. The usual load is three maunds (about 2½ cwt.), but two maunds are preferable. Stages long, about double those used in India. Servants travel sitting on their bedding, all being mounted. The animals are usually well cared for in rather an odd way.

It is a mistake to travel light in Turkistan, where the local snobbery judges a man by his caravan. The fact of a certain number of horses and servants adds very much to the success of the journey. The wise traveller will always travel with his caravan, which is often dull, but better than losing it or being lost oneself." *R. Schomberg.*

"In Tamberias the Government of San Juan very kindly supplied the expedition with a caravan of twenty-five mules with four experienced mulemen and guides and the necessary pack and riding saddles. It was necessary to leave behind part of the baggage as the pack-mules could not carry the entire load of 3000 lb. of food, equipment, and instruments."
Daszynski. Andes. 84.217.

"The mules themselves are sensible of the caution requisite in these descents, for coming to the top of an eminence, they stop, and having placed their fore feet close together, as in a posture of stopping themselves, they also put their hinder feet together, but a little forwards, as if going to lie down. In this attitude, having as it were taken a survey of the road, they slide down with the swiftness of a meteor. All the rider has to do is to keep himself fast in the saddle without checking his beast, for the least motion is sufficient to disorder the equilibrium of the mule, in which case they both unavoidably perish." *Ulloa, trans. by Sheppard. Ecuador.* 86.418.

"My halt at Shiraz enabled me to arrange needful transport in the shape of a dozen and a half of hardy Shirazi mules, essential for the rough journey before us. Already in 1915 I had learned to appreciate the excellent qualities

of these animals when travelling during the war along the Perso-Afghan border to Sistan. Ever since I had looked out for a chance of travelling with those plucky muleteers from Shiraz who know so well how to look after their animals. My expectations as regards these transport arrangements were fully justified. In the course of my tour, which covered aggregate marching distances of some 1300 miles, I never experienced the least trouble on their account, however bad the stony tracks were or however difficult to secure adequate fodder. Nor was a single mule ever found to suffer from serious sores."
Stein. South Persia. 86.490.

"Except for motor trucks, which could then travel only as far as Ambo, some 70 miles west of Addis Ababa, mules, donkeys, porters, and camels are the normal methods of transport. Mules and donkeys are most common, for the weight of their loads and the length of their daily march compares favourably with their small cost of hire. It was found that mules could maintain an average pace of 3 miles an hour for 15 to 20 miles a day; while donkeys maintained an average pace of 2½ miles an hour for 10 to 12 miles a day. The advantage of the donkey is that it costs less and is immune from the ravages of *doba* fly, of which there are belts in the Wama, Nejo, and Dadessa valley areas and in Bani Shanqul. Porters, though faster, carry but small loads and are infinitely more costly, while their periodical bouts of *tej* (fermented honey) drinking are as troublesome as the sore backs of the animals. Camels, capable of carrying heavy burdens, being immune to *doba* fly and not prone to sore backs, are employed extensively between the Sudan and Addis Ababa during the dry season (November to May). This method is exceptionally slow, owing to the hilly nature of the country and the numerous stretches of clay which, after the slightest rain, render sections of the route impassable to camels."
Capt. A. Dunlop. W. Ethiopia. 89.508.

Yak should never be bought but hired at the rate of about 1 rupee a day each, which includes the services of one man for each six animals. Yak are liable to stampede. They move in herds, and are clumsy in file except on a beaten track uphill in snow. Unladen yaks are very useful in opening snow passes. Take them up by night on hard snow, and drive them down on the soft snow in the morning. Take them up laden next day on the same track. The yak can keep on indefinitely at about 1½ miles per hour, grazing as he goes. His load is the same as a pony's, 160 lb. The yak does not like the scent of a European, who should not stand near during loading.

Sheep are used in Eastern Ladakh and part of Tibet, with loads made up in bags. They move in flock, not file, and keep condition in almost grassless country where yak and ponies cannot find food. One man controls twenty to thirty laden sheep. The mutton is rather tough but fresh.

"One man can look after thirty sheep, each of which can carry 20 lb. Captain Biddulph in 1873 covered 330 miles in twenty-three days with sheep

transport, and had only one casualty though there was very little grazing. There is no doubt that they can carry on with much less grass or water than ponies and yaks." *Mason. Shaksgam.*

In North China transport is by cart or pack animal. Travelling by cart will also usually be by contract. With pack animals on the more out of the way routes it may be necessary to hire them at so much per day per animal, formerly at about, say, the equivalent of two shillings per day per mule. The big mules of North China carry loads up to 200 Chinese pounds (one and a third English pounds) apiece; the small mules of Yunnan and the Tibetan border little more than half as much.

In some parts of High Asia the native caravan men leave the riding or pack saddles on the animals night and day throughout the journey. In this and other respects it is best to follow local custom.

Ula is the official forced transport system of Eastern Tibet, the villagers having to supply the traveller with animals from stage to stage. *Ula* is unpopular and liable to abuse, and the foreign traveller should see that the animals with which he is provided as *ula* are paid for at a fair rate.

Carts are more economical than pack animals and are easier to lead. In the dry sandy country of North China, Turkistan, and the Mongolian border long-distance carts travel a good 3 to 4 miles per hour. For speed and comfort of travel select carts in preference to pack animals where the country permits.

Camels are slow and camel caravan very monotonous: need camels only on a Gobi journey, a special line in Central Asian travel.

Yak only likely to be used to supplement mule or pony caravan in crossing high passes in Eastern Tibet or the Pamir region: unique in their ability to plough through deep snow and maintain foothold on bad ground at high altitudes.

The traveller himself will probably be riding: use the Mongolian pony in North China and Mongolia, the Kansu (Sining) pony in Eastern Tibet and the Kokonor, and the Karashar or other Turki breed of pony in Chinese Turkistan. Select a pony that can amble (pace, *tsou* in Chinese) and avoid one that has no gait between a slow walk and a trot. For a long journey a good ambler is invaluable; the Chinese, Mongols, Tibetans and Turkis are well aware of this. The keener the pony is to go, the less tiring he will be to ride. Use a foreign saddle; one with a high cantle is less tiring than the ordinary hunting or polo saddle. No one without the anatomy of a native of the Far East can be comfortable on a Chinese, Mongol, or Tibetan saddle. The best native saddle is one of the Andijani type.

If you suffer from headache or mountain sickness at high altitudes, do not dismount uphill, but ride your pony, mule, or yak up the pass;

refrain from smoking; and do not be alarmed if you wake up short of breath during the night; a recumbent position sometimes brings this on.

E. Teichman.

Owing to tsetse fly, mule trains are unknown in Africa, but mules are ridden in some areas; they will stand exposure better than a horse, and are less liable to attacks of horse sickness. Good mules were traded from Abyssinia, and before the motor came were widely used.

Donkeys are indigenous among the Masai of East Africa, and in the highlands and other parts free from fly; they are hardy, live on the country, are cheap, and will carry 120 lb. To avoid sore backs hang the saddle-bags on a well-padded A frame, and have well-padded breast and crupper pad. Drivers' duties include loading, and care of the pack gear; pack animals should never be overloaded, and their pace should not be forced. *C. W. Hobley.*

MOTORS

The justly condemned performance of those who take a pride in making cars go on journeys in which the whole attention must be concentrated on getting the car through, and it is a mere impediment, should not obscure the fact that in certain countries, notably the Libyan Desert, the careful use of cars has extended the possibilities of travel, and journeys have been made which could not have been carried through by any other means. The present section will be devoted to this kind of motor travel; briefer attention will be given to the use of cars as a means of getting rapidly from place to place. There will be only slight reference to navigation by compass and speedometer, which is treated already in Volume I. On safety precautions in waterless country it is impossible to generalize. The fact that an aeroplane or a car may cover great distances with remarkable ease seems to produce some indifference to the precautions proper against mechanical failure.

The most complete account of how to adapt a car for long-distance travel in waterless desert is found in papers in *Geographical Journal* by Major R. E. Bagnold, from which the following extracts are made:

CARS IN THE DESERT

Journey north and north-west of 'Ain Dalla, November 1929. 78.13.

Unfortunately there was no opportunity of making an advanced dump of supplies beforehand, so lorries instead of light cars had to be used to enable us to carry with us enough petrol and other stores for

the whole journey. This made the going slower than was intended. The lorries, loaded to their utmost capacity, were continually sticking in soft places, and much time and petrol were expended in extricating them. Our transport in all consisted of two New Ford 30-cwt. lorries and a touring car of the same make.

For economy in water consumption each vehicle was fitted with a simple condenser consisting of a tube from the radiator top to the bottom of a 2-gallon can bolted to the running-board and kept half full of water. The ordinary overflow of the radiator was blocked up. By this means both evaporation and splashing losses are avoided, as also are the actual boiling losses, until the water in the can is raised to boiling-point. A short halt then causes a condensation in the radiator, and the resulting vacuum sucks water back into the radiator till it is quite full. This system has always worked well, and water losses have been negligible.

For extricating the lorries from soft sand a pair of steel channels 5 feet long weighing 30 lb. each were carried. These channels proved of the utmost value. In fact, nothing could have been achieved without them. A pair of rope ladders were also carried for extricating the touring car; they also were invaluable.

Fortunately the soft patches are seldom more than a dozen yards wide. Any vehicle however entering one will drop axle deep with the abruptness of falling over a high step. The method of extricating a car is always the same. Unless very deeply stuck, sand is scooped away in front of the rear wheels, leaving a sloping groove reaching down almost to the bottom of the tyres. The channels are then laid in the grooves and pushed as far as possible under the rear wheels. The latter, having now a firm steel roadway to bite on, will move the car forward at least 10 feet. One complete operation and a 10-foot advance occupy only a few minutes but necessitate a great deal of physical effort. When, in addition, rope ladders are laid out ahead of each front wheel, a touring car can usually be extricated in one operation, the momentum acquired being enough to carry the car out of the soft patch. The lorries often sank too deep, and it was necessary first to jack up the rear axle before the channels could be used. This took half an hour or more. At first, till the general organization of the dunes was grasped, and we had learnt to guess where the bad patches were most likely, the vehicles stuck several dozen times a day.

As regards transport, it was now clear that 30-cwt. 4-wheeled lorries, reliable and very easily handled though they were, are not suitable for dune country purely because their weight makes them extremely difficult to extricate when stuck in patches of liquid sand. On the other hand, the Ford touring car's performance was so remarkable that by

the end of the journey I was confident of getting across any dune country of the type we had met. The low petrol consumption, 14 miles per gallon, and its great weight-carrying capacity, 1700 lb., gave promise of a self-contained range of action of 1200 miles. An examination of our route through the sand showed that owing to the zigzag course, all straight-line mileages in this country must be doubled when calculating car distances and fuel consumption.

Journey to Sand Sea and Uweinat. October, November 1930. 78.19

Accordingly three New Ford car chassis were bought and fitted with light box-bodies. All unnecessary parts such as mudguards were removed to save weight. Very careful attention had to be paid to packing now that we had nothing but light cars, the two aims being to economize weight and to reduce the risk of damage and losses due to vibration and bumping. Everything has to fit tightly and yet be easily off-loaded. The best unit of packing in this part of the world is undoubtedly the 8-gallon wooden petrol case, holding two 4-gallon tins. The box bodies of the cars were built so that their inside measurements were a whole number of cases wide, long and high. As far as possible all stores, whether food, spare parts, tools, or petrol, were packed in these cases, which are a convenient size and weight for any handling that has to be done. The whole assemblage of cases was held down by battens fitting over bolts rising from the outside walls of the body and pressed down by butterfly nuts. We found that by this means there were no breakages or loss of petrol due to leaking tins. Water was carried in new 2-gallon petrol tins in rows seven a side bolted along the running-boards of the cars. A slight tinge of red rust appears in the water after a week or so, but it has no effect on the taste of the water or on its tea-making properties. Rubber washers were fitted in the stoppers instead of the usual leather ones, and no loss of water was experienced. Our other equipment was the same as that of the previous year (see Appendix I for survey gear) except that in view of the unreliability of magnetic compasses when fixed in cars, I fell back on a sun-compass which I had used on other expeditions with success. A description of it is given by Newbold in Appendix I. A dump of 500 gallons of petrol was sent in advance to Dalla on camels from the Nile Valley.

The direct route between Bahariya and Dalla, avoiding the very soft ground in Farafra depression, lies over a rocky limestone plateau containing wide beds of soft clay which, while easy enough for our present light cars, had given a great deal of trouble the previous year, when heavy lorries were used. The difference was remarkable considering that the cars were now grossly overloaded compared with the weight they would have to carry as touring cars on ordinary roads.

The boundary between hard and liquid sand is usually very sharp. Superficially it is quite invisible, except over a large area as a faint change of reflecting power in certain lights. Groping with one's hand however in the mobile material, the firm sand can be felt with the fingers somewhat as one feels the inside wall of a bucket of water. It is strange that the grains of very fine sand driving over the surface in a wind have not been caught by and mixed with the coarser grains as they are mixed in the firmer material. The firmness of the sand elsewhere is very striking as there is no sign of crust or caking, and the grains are perfectly loose on one another. The sand on the eastern slopes of whalebacks is so firm that the piling of the grains is not even disturbed by the drag of a car climbing in bottom gear at such an angle that it eventually comes to a standstill. Then and then only does the piling give way. On the level tops of whalebacks the piling, except in the liquid patches, is always firm enough to hold while a car is moving, but often at the moment of stopping, even gently without the brakes being applied, the piling gives way with a loud "grunt." It is as if some kind of time-fatigue is involved. Once the piling is disturbed, a car can rarely start without channels being laid.

The performance of the Fords was indeed striking. With our simple condenser fittings they had lost no water from start to finish. There had been no mechanical trouble of any kind other than the unfortunate breakage of the crown wheel which had lost us one car. The maximum load carried over continuous bad country was 1800 lb. per car. During the worst stretch of soft going, the petrol consumption had not fallen below 14 miles per gallon even with this load. The day's run, even in the most difficult dune country of the Sand Sea, never fell below 65 miles, and the average over the total number of running days was 138 miles per day.

Journey to Uweinat and el Fasher. September–November 1932. 82.229.

The transport arrangements for all our past desert expeditions, evolving side by side with the evolution of American commercial vehicles suited more and more for desert work, have been designed to meet the following requirements: Personnel, food, water, etc., and essential equipment must be carried rapidly and without mishap as far as possible and as cheaply as possible across the most varied type of desert country without any supplies whatever being available *en route.*

Choice of car

The type of car must be suitable for the country to be traversed. If, for example, the country includes areas of very soft sand such as is found when crossing dunes, where any type of car, even with six wheels, is liable to get stuck, it is important that the car shall be light enough to

be pushed out by the combined efforts of the party. If the country contains bad rock areas the chassis must be so flexible that the danger of its twisting so badly as to crack shall be reduced to a minimum. In country containing long stretches of soft sand, the car must have sufficient engine power to pull it through, and a sufficiently effective cooling system to prevent boiling.

The car must be reliable. This means that the make must be a sound one and the model used must have been proved by past experience to be suitable for the type of country to be traversed. The model should be at least in its second year, if not in its third, both for the above reason, and also to enable a sound estimate to be made of the faults which are likely to occur and of the spare parts which must be carried. The cars themselves must be new and not second-hand. The behaviour and idiosyncrasies of the cars must be well known to the members of the party who are going to drive and look after them. The design must be simple so that replacements can be fitted and repairs made without trouble. The petrol and oil consumption must be low for the weight carried. This last requirement is another argument in favour of the light car rather than the lorry. We found that although a 30-cwt. lorry will carry twice as much petrol as a 15-cwt. car, its petrol consumption is more than double, so that its maximum range is less than that of the car. There is no doubt that at present [1932], in the way of fulfilling all the above requirements, the Ford Model A car chassis stands by itself. I cannot see any advantage to be gained from the use of a six-wheeled car. With modern balloon tyres and some knowledge of sand running and of when to decrease the tyre pressure usefully, the four-wheeled Ford will tackle nearly all sand conditions successfully. The six-wheeler is complicated, heavy, and clumsy, and it uses more petrol for the load carried. The following remarks will therefore be based on the use of the Ford Model A chassis.

Carrying capacity and petrol consumption

Excluding a body weighing 550 lb. we find that this chassis will carry without risk of breakage a load of about 1750 lb. The petrol-consumption on the worst portions of the journey was 12 miles per gallon, and though the average mileage per gallon is about 14, I always work on the figure of 12 to allow for leakage and unforeseen troubles. Twelve miles per gallon, or roughly one 8-gallon case of petrol per 100 miles, is a safe figure for any type of desert country.

Number of cars and size of party

Our expeditions have never included native or other paid drivers. I think it is agreed that except in very unusual cases the performance

of motor transport is reduced to a very small fraction of what is possible by employing drivers, native or European, who have no direct stake in the expedition and who are not sufficiently intelligent or interested to treat a car as it should be treated, with the same sympathy with which an English owner regards his hunter.

The ideal number of cars for a compromise to be struck between speed and absence of delays on the one hand and safety on the other is undoubtedly three. The ideal car crew consists of two people. But the actual number of cars will depend of course on the requirements of the expedition in personnel and stores to be carried.

Load and range of action away from supply base

The load consists of two parts: the "pay" load of passengers and their kit, spare parts, instruments, arms, etc., and the "supply" load of petrol, oil, water, and food. The pay load remains the same throughout the journey and is usually determined by outside considerations independent of distance and time. In our case this load amounted to 700 lb. per car, being composed of two men and their kits, spare parts, rifles and ammunition, theodolites, W/T receiver, cameras, maps, tools, spare tyre covers and tubes, and other oddments. The remaining 1050 lb. was available for the supply load. A typical supply load per car was as follows:

Petrol, 12½ cases (100 gallons), enough for 1200 miles ..	750 lb.
Oil, 2 gallons engine oil and 1 gallon gear oil	30
Water, 18 gallons, enough for two people in late summer, autumn, or winter for 15 days	180
Food, 90 lb., enough for two people for 15 days	90

At one time, by slightly overloading the cars, we set out with 110 gallons of petrol per car, or a safe supply for 1320 miles. We could probably have done 1540 miles at our average of 14 miles per gallon.

By varying the conditions, *e.g.* supposing we only needed petrol for a journey of 800 miles, we could have carried food and water enough to enable us to stay out for twenty-seven days. One advantage of being able to travel thus self-contained for great distances is the saving in expense by avoiding the necessity of having to arrange for supply convoys, either car or camel, both of which cost a considerable amount when long distances are involved.

Packing and design of the car body

To save weight the body of the car should be as small as possible. A large body, overhanging sideways, besides being heavy, causes unnecessary strain on the springs when the car lurches over at a steep angle while going over bad rocks or steep sand slopes. Careful packing

is necessary so that there is no waste space and so that the stores are not damaged by undue movement inside the body. Petrol is supplied in Egypt, the Sudan, etc., in thin square 4-gallon tins, two of which are packed in a thin wood case of 8 gallons. Ideal packing is arranged by using these same wood cases as containers for all the other stores carried, and by building the car body so that its inside dimensions are an exact number of cases in width, length, and height.

The commercial type of "pick-up" body made of pressed steel is hardly suitable for a long expedition as there is insufficient space inside it. It is no lighter than a specially designed box-body of light wood which can be made abroad for £15 to £20.

It is important to provide as much easily accessible outside locker space as possible where tools, cameras, and other articles can be stored which are wanted in a hurry, or which are delicate, such as chronometers, aneroids, etc.

Alteration to the standard chassis

Very few are required. The most important is the addition of extra leaves to the rear spring. We use springs of twelve leaves in rear and the standard springs in front. The mistake is sometimes made of strengthening up the front spring with extra leaves. The result is that when one front wheel lifts over a large rock it is not the spring which gives but the chassis frame. With too strong a spring the chassis frame twists to such an extent that in time the front cross-member cracks in half. It is better to break a spring and replace it. With a strengthened rear spring the same thing happens; the rear cross-member ends by cracking, but here there is no alternative if heavy loads are to be carried.

The inevitable twisting of the chassis frame causes the top of the radiator to move sideways in relation to the scuttle of the car, to which it is attached rigidly by stay-rods. Again, something must give, and either the radiator is strained till its joints come apart or the stays are torn out of their sockets. Even the presence of the bonnet, we found, tends to strain the radiator by holding it too rigidly. By removing the bonnet altogether and also one or both of the tie-rods, no amount of rough going was able to damage the radiator.

It is a great help both when driving and when tending the engine, front axle, etc., if the front mudguards are discarded; though they are badly wanted for mud roads and when traversing sub-desert country where *heskanit* and other burrs abound. When the running-boards are used for carrying water tins their supporting brackets should be strengthened if the additional support given by the mudguards is removed.

Economy in radiator water was effected as described in my article in the *Geographical Journal* of July 1931, p. 13. The cars used practically no water during the entire journey. [See p. 162.]

Spare parts

The choice and number of spare parts carried is a matter of opinion. One can either carry everything which might break or wear out, or one can confine one's self to the few articles which are known to be required. We took the latter course. If a major unexpected part does break it is ten to one that it has not been included in the list of spares, even though the latter is so large as to overload the expedition. Apart from a few repair materials and small replacements, we only carried spare springs, two front and two rear, and spare front and rear cross-members complete with sets of bolts with which to replace the rivets one has to chip away to remove the broken members. Harding-Newman and I together replaced a rear cross-member in four hours. The only serious faults which occurred were the breakage of two front springs and two rear cross-members. One main engine support bracket cracked in two places, but I think that was due to a flaw in the material.

Tyres and their management

The necessity for running with soft flabby tyres when crossing areas of soft sand is well known to all who have driven for any length of time in sandy countries; but it is elsewhere so little realized that it may be as well to emphasize it here. Provided there are no rocks or large stones with which the tyres may come into collision, it is perfectly safe to deflate them till they are almost flat. The only risk is of the cover creeping round the rim and tearing the valve out of the tube. This is easily prevented by keeping the outer valve-retaining-nut very tight or by coating the rim with some tacky paint.

In rocky country however tyres will not last any distance before bursting if they are not kept thoroughly inflated, even at a higher pressure than the makers advise. If this is done covers will come to little harm even on the worst rocks. (Our experience has been with Firestone and Goodyear tyres.) The great difficulty is in mixed country containing both soft sand and rocks. Here avoidance of tyre trouble is really a matter of strength of mind. For one has to be continually deflating the tyres and pumping them up again. For this type of country a really good tyre pump is essential for each car. We used, in addition, two "Nev-a-Tire" mechanical pumps made by Messrs. Williams and James, of Gloucester. They were a great success and rarely got out of order.

The Goodyear Tyre Co. has lately introduced a super-balloon tyre

or "air-wheel," of very low pressure. From a few trials in Egypt it looks like removing even sand-dunes from the rapidly diminishing list of obstacles to desert motoring. It remains to be seen what effect collisions with rocks will have upon it. [Written 1932.]

Unsticking gear

The same methods were used as described in my paper (*Geogr. J.*, July 1931). [See p. 162.] I do not think that steel channels can be improved upon. We found a new use for them when our cars became bogged in the bottomless mud of the oases when we broke through the crust of salt pans while trying to cross them. Sloping excavations were made as usual in front of the rear wheels and the channels laid in them. But now the sledge hammer was brought into play to drive the channels well back under the wheels for 2 feet or more. The mud and crust on which the car was resting was now dug away, allowing the channels to take all the weight through the wheels. The car would by this means usually drive out under its own power.

Safety principles

The possible results of a shortage of water or petrol far out in the desert are obvious. The following Rules of the Desert have, I think, been adhered to consciously or unconsciously by all experienced users of motor transport when very long journeys are undertaken in unknown country. Perhaps it may not be out of place to state them here. (1) Enough care must be taken to obviate the risk of a total breakdown anywhere out of reach of help. (2) Petrol consumption must be estimated at the maximum rate over the worst type of country likely to be met with, and enough must be carried to enable the party to return to their base or reach other help if it is found impossible at any point to proceed farther. (3) No individual or single car must be left alone out of sight of an obvious unmistakable landmark. (4) The party must be confident at all times that they either know where they are, or have the means of finding out by astronomical observation. (5) Water is to be used for drinking only except at wells after the containers have been filled. A margin of 60 per cent. extra water should be carried over and above the estimated requirements. By rigid adherence to these few rules a party which includes skilled mechanics among its members should be able to undertake any desert journey with confidence.

The whole journey totalled over 6000 miles, including the two runs from Kissu to Selima and back. Of this distance more than 5000 miles was over new country with no existing tracks. Much of it was very bad going for cars, being covered either with large stones and boulders, or,

in the south, with hidden water runnels of hard mud. Apart from the cracking of one main engine-supporting bracket, which occurred within sight of the Tibesti Mountains and which was partly responsible for our decision not to go farther west, no serious fault occurred to any of the four cars, which at times were twisted and bumped about unmercifully. . . . Were it not for the great reliance which can be placed on these cars when driven and looked after by a party with real knowledge of their insides, no such small expedition as ours could safely penetrate far into the desert with but four cars and practically no load of spare parts. The gross cost per member of this type of expedition works out at about £20 to £30 per thousand miles, without allowing for any rebates, such as the proceeds of the sale of the cars afterwards.

Additional notes 1936

For writing, etc., it is worth while being comfortable. A petrol case as a seat and a rolled-up valise as a back rest, propped up against a car, are excellent furniture. Illumination by head lamps is not satisfactory: people cross and stand in the light. Have inspection lamp on long flex slung overhead between two cars.

Prolonged driving across desert country entails considerable nervous strain, to minimize which make living conditions as comfortable as possible while avoiding excessive expense, complication and delay, extra weight and loss of carrying power.

Protection from the sun is often not as essential as is supposed. In any case it is wrong to treat a car hood as a protection against sunstroke: that is the function of the head-dress. In fitting a hood take care that it or its supports do not impede (*a*) the rapid ingress and egress of the car's occupants; (*b*) access to its stores; (*c*) the free passage of air. A simple flat cloth roof supported by four fixed vertical posts is often sufficient.

The *Koolcushion* is two open-woven grass or cane pads hinged together. One sits on one and leans back against the other. Adequate ventilation is assured. These add greatly to comfort in the car, and prevent excessive sweating at the back and seat. *R. A. Bagnold.*

"The strain thrown on the cars and the physical efforts necessary on the part of the personnel are almost incredible. Even steam condensers, which all old desert hands rig up on their cars and which Major Bagnold's party found so useful, are of small avail in hot weather, when the temperature of water in supply tanks, radiators and condensing cans is already not far off boiling-point from the direct rays of the sun. Even on hard ground, when running south with a following wind, engines speedily become overheated, while on low gear in soft country they get fiercely hot in a few minutes. Traversing dune country is in fact a tough proposition." *Beadnell. Libyan Desert.* 78.37.

"There are however certain advantages in travelling on foot of which the motorist is deprived. The pedestrian is unhurried. He can stop to investigate anything of interest without upsetting his programme; and he is likely to notice detail that will escape the traveller at speed, a matter of some importance in a waste whose utter emptiness makes the minutiae of nature of more interest than the general geographical features."

Orde Wingate. Libyan Desert. 83.281.

"We regretted afterwards we had not stopped longer to examine this area. It is one of the disadvantages of car travel that after the strain of continuous driving over country which at any moment may wreck a car, the relief of finding a stretch of good going makes it very difficult to bring oneself to stop."

Bagnold. Libyan Desert. 78.30.

"Sudanese drivers and one cook. For our transport we had selected four A-type Ford cars with box bodies. Our equipment was with two exceptions typical desert equipment. For the first time on any desert expedition the new enormous balloon tyres known as air wheels were tried. The tyres are 9 inches wide and are intended to be run at 12 lb. pressure. We were however forced to run them in the neighbourhood of 20 lb. owing to our very heavy loads. We knew, having tested them, that they were excellent in soft going. The gamble was whether they would stand up to the work over stone fields and rocky ground. There were two schools of thought, one that the tyres would get cut badly owing to their low pressure; the other that the low pressure was advantageous, as there being less resistance, stones would be merely pressed into the tyre without damaging it. The latter school fortunately was correct, and although of course we had badly cut tyres and internal fractures of the fabric, they were certainly not more than one gets with the ordinary size tyre. Over the real liquid sand however they were as useless as ordinary tyres. They even had a disadvantage, as owing to their bigger surface a car once stuck was considerably more difficult to get out. I doubt whether a car on any tyres can be driven through liquid sand."

Penderel. Gilf Kebir. 83.453.

"By running day and night we accomplished the 807 miles in forty-six hours, which considering the bad going and the frequent and long stops to dig the car out of the sand, was most creditable to the French driver, who himself drove for thirty-eight hours. We started late in the morning so as to negotiate the worst desert tract after the cool of night time had settled the sand more firmly." *Mrs. Patrick Ness. Sahara.* 77.319.

"Regular supplies of paraffin and petrol were also essential. In this country these are supplied in 4-gallon tins, the metal of which is so thin that they are easily damaged in transport, and as evaporation, especially of petrol, was very high, great care had to be exercised to avoid an unforeseen shortage."

Parker. Sudan. 84.63.

"We used three model 46, 4-cylinder, Ford 'pick-ups,' with two seats in front and a light box-body of pressed steel, heightened by a wooden framework, behind. The cars were equipped in much the same manner as on Major Bagnold's 1932 expedition, of which Harding Newman and I had been

members. On that occasion we had not the advantage of the 9×13-inch Dunlop 'airwheels' which we used with such success in 1935. Broadly speaking, desert sand may be divided into three types: (1) That in which no car will stick. (2) That through which it is often possible to force a way by keeping up speed and by intelligent use of the slopes of the ground. (3) That in which any tyre yet made will bog. The use of 'airwheels' means that one has less difficulty on sand of the second class; one's immunity from 'sticks' is greatly increased. Moreover the large low-pressure tyre acts almost as an additional spring on each wheel relieving the strain on the car over rough going.

April 1 was appropriately remarkable for the worst sandstorm we encountered. It blew for hours on a south-west wind with gusts up to 60 m.p.h. Yet in spite of the fact that horizontal visibility was reduced to about 200 yards we were able to use the sun-compass almost the whole time. A dust-storm, often miscalled a sandstorm, may be 1000 feet in vertical thickness, almost turning day into night. But a storm of true desert sand, and this was the worst I personally had ever been in, yet allows the sun's light to case a shadow on the compass dial because the blowing sand does not rise more than 30 feet or so above the ground.

The performance of the Ford cars was most satisfactory. They were usually overloaded; on occasion we were carrying 2300 lb. and the makers' specification is 1700 on normal roads. The major breakages, which we quite expected, were four main leaves in the front springs and five rear spring shackles. To replace the latter a spring-spreader is needed. This is not an easy tool to obtain; we had one made in Cairo, but it soon bent and became useless, but by the ingenious use of many jacks Harding Newman dispensed with it. On this model the battery is placed too low for very rough country; the actual clearance is sufficient but it is situated half-way between the front and rear axles and gets damaged when the car is straddling an obstacle. Our petrol consumption was a shade over 13 m.p.g. That this is rather lower than on previous expeditions may be due to the use of airwheels, but their enormous compensating advantages easily outweigh this fact."

Shaw. Libyan Desert. 88.193, 207, 209.

"Moreover, the wireless set appeared to survive all the bumps over rocks, boulders, soft sand, and everything else, for it worked up to the last. It was put on the footboard in a box well sprung inside and packed round with rubber inner tubes. Unfortunately the chronometers did not behave so well. They were carefully packed in cotton waste in a wooden box and kept horizontal, but they did not seem to survive the bumps peculiar to a motor vehicle, because they kept very bad time indeed and varied 5 seconds or more daily each way from their normal reading. They were going very well before we left Cairo, but you will realize that if the wireless set had not worked the chronometers would have been of very little use for obtaining longitude."

Holland. Libyan Desert. 78.14.

"Ten packages of 100 lb. each are much less trouble to handle in loading and unloading a car which has stuck than innumerable 20–50-lb. parcels. If you have to unload a stuck car and then load it again several times a day, the handling becomes more and more tedious and less and less careful. The

fewer the packages the more carefully can they be packed and the less damage occurs over the next piece of rough ground." *Francis Rodd.*

"We had with us two Morris six-wheeler trucks, which were invaluable. We could get very nearly anywhere with them except in the really hilly districts. The Somali is not a good motor driver; he cannot understand the use of gears or how to change down. We did not like to risk our six-wheelers, and so these were always driven by a member of the Commission. We had with us a sergeant R.A.S.C., who kept them throughout in excellent order. At the end of the time each truck had developed a crack in the chassis at the same place which indicates a weak point there. The tracks supplied with the trucks are useful, but can only be put on by reversing on to them, so you must put them on before you get bogged." *Stafford. Somaliland.* 78.106.

"On my arrival at Rejaf, in the first week of last March, I saw for the first time the car in which I was about to embark on 5500 unknown miles to Algiers. It was a 10-cwt. 22-horse-power Chevrolet. We had ordered a Kenya body—half tourer, half lorry, and most comfortable. The company delivered a grocer's delivery van body, made for cheapness and upholstered for economy. The grocer's van never let us down for mechanical causes; it brought us back to London, and its heart still beats strong in Scotland as a shooting lorry.

Equatoria is, in fact, only just fit for motor traffic. The roads are passable, or, as they say on French maps, *automobilisable*; but tyres and spare parts are unobtainable save at Bangi, in the extreme south-west corner of the colony; and petrol is not a case of another pump in the next village. At Bangasu we had to stock for two days to carry us to Bambari; there we learned that, although on our road to Chad we should pass two comparatively important centres—Fort Crampel and Fort Archambault, at neither place could we expect to find commercial petrol, and that we must carry for the whole 700 miles to Lamy." *Tweedy. Central Africa.* 75.2, 7.

"The lorry's load [25-cwt. Morris] was half a ton of petrol, oil and spare parts, the boys and their loads, the outfit and provisions, and it could have accommodated me as well had I not been advised to provide myself with a separate car, not only for the extra comfort and for the added reliability, but because of the better impression it would produce on the chiefs who were not accustomed to a woman travelling alone."

Mrs. Patrick Ness. Lake Chad. 77.307.

"Soon after leaving Kanye the leading lorry crashed into an ant-bear hole concealed in the bush, into which the front wheels disappeared. This meant all hands to the pumps, spades for digging out, jacks and blocks for levering up the car, and much pushing and hauling. In order to avoid repetition I may say here that this form of amusement was repeated on many occasions, and it is a marvel that the lorries survived it. That, together with the terribly deep soft sand, and lack of water, formed our principal difficulties; and the number of times that the lorries stuck in the sand and had to be dug out is too wearisome to recapitulate. But we had no major accidents: a broken back-axle, a broken front spring, a broken ring-pin, a few minor breakages, and a number of punctures were the only troubles our lorry suffered; and I am proud to

say that our English car, fitted with English tyres, went through the whole expedition without a single accident or even a puncture—a triumph of British workmanship when it is realized that we were pushing through thick bush, reaching sometimes above the top of the hood of the car, over bumps and holes and roots, down to third speed in thick heavy sand, doing sometimes 3 or 4 miles in an hour, and hardly ever on a piece of smooth going."

Rey. Ngamiland. 80.297.

"The task of extricating the lorry turned out to be extremely difficult. There was no wood, scrub, or grass anywhere near to serve as a corduroy, but we fortunately remembered that we had a number of thick pine planks which were being used as decking to separate the rows of petrol tanks. With the aid of these we were able to obtain sufficient surface to jack the wheels of the lorry out of the mud. We then filled in the holes with shovelsful of the dry saline crust and placed other planks underneath the wheels to form a track. In this way we were able to back out of the mud, putting down fresh planks about every 8 feet. It was a long and tedious process, and as soon as we got the car back on to the hard surface we decided to put on the caterpillar tracks. We discovered, however, that these were quite useless in the bluish slimy clay which is frequently found beneath the hard saline crust of the lake. If anything, they dig the car in faster than the ordinary wheels. The planks proved our salvation on many future occasions, and indeed it is probable that without their assistance we should never have been able to get back to hard land."

Clifford. Kalahari. 75.21.

"From Nova Lisboa roads for motors with pneumatic tyres only radiate to all parts of Angola. These roads are well located on watersheds wherever possible, 8 metres wide and well drained, with permanent bridges across rivers and streams on the main routes. They are well maintained, but not metalled, but in many cases have a topping of laterite, which is very effective. Ox waggons or any type of hard-tyred vehicles are not allowed on them, consequently it is a pleasure to motor on them, and they can be considered some of the best roads as far as one has seen to compare in various other parts, in Africa."

Varian. Angola. 78.511.

The motor bus, lorry, and car are extensively used in China, Mongolia, and Chinese Turkistan. A system of motor roads in Central China; and petrol obtainable in the larger towns served by them; in North China such motor roads as exist mostly of mud, impassable in wet weather. Public motor bus services run on the new roads, but standard of comfort is Chinese, and a severe strain on endurance. Usually impossible to take luggage, bedding, kitchen equipment, and staff necessary for comfort on a long journey in the interior. This drawback applies also to the Chinese air lines which nowadays connect the principal centres of China Proper.

In Mongolia and Chinese Turkistan lorries travel across the desert along the cart tracks and camel trails: special arrangements for petrol

by sending supplies ahead by camel caravan, to be picked up. Light lorries, with powerful engines and strongly built, to carry 3 to 4 tons, most suitable for desert travel; dual rear wheels useful but not essential. Carry equipment for extricating lorries from sand and mud, such as spades and picks, towing hawsers, big jacks, rope mats, and planks. All the necessary outfit supplies and advice obtainable at the starting point on the Chinese border. With proper organization and preparation; adequate mechanical knowledge and experience; careful and slow driving over bad ground; and a guide who knows the route and where to find wells and desert wood, the lorry provides the speediest and most luxurious travel in Central Asia; without adequate preparation it may easily lead to disaster. *E. Teichman.*

"Although happily motor cars are yet scarce in Sinkiang, they have begun; but the rivers and sand delay the development of this odious form of transport." *R. Schomberg.*

"Motor transport has revolutionized travel in Mongolia and Chinese Turkestan, and one can nowadays accomplish in a few weeks the long journeys which formerly occupied many weary months of travel by camel caravan or cart. Motor cars and trucks first made their appearance in Chinese Central Asia after the war on the grassy steppes of Mongolia, which are specially suited to motor traffic, and as long ago as 1920 I travelled in one of Mr. Larson's Dodge cars from Kalgan to Urga. It was not however until many years later that motor traffic was developed in the more sandy wastes of the Western Gobi and Chinese Turkestan.

The motor vehicles at present in use on the Sui-yuan to Hami run across the Gobi are mostly Ford V8 3-ton trucks, which have proved themselves to be strong, fast, powerful, and reliable, and have the advantage of being familiar to the Chinese and Mongols who drive the route. Only the strongest machines will stand the strain of Gobi travel.

Where possible it is best to follow the old camel trails, which are firmer and better going than the rest of the desert. Over long stretches of the Gobi the surface is gravel over sand, and once off the camel trails the heavy trucks break through the top surface and have to plough for hour after hour through the sand on low gear. The worst part of the road from Sui-yuan to Hami, for sand and heavy going, is the first half, to the Etsin Gol. Thereafter the going, though rocky and stony in places, is better. Some of the worst going is across the sandy beds of dry rivers, and some of the best on the smooth firm surface of dry lake bottoms.

Estimates of the amount of petrol required should be based on a minimum average of 4 to 5 miles per gallon for a loaded truck in the desert, allowing for the necessary low-gear work in sand and bad ground."

Teichman. Gobi. 89.299

"Each group started with seven light six-wheeled caterpillar-tractors drawing two-wheeled trailers, Haardt from Beirut on 4 April 1931, Point from Tientsin two days later. The *Groupe Pamir* reached Kabul on June 9, Peshawar on the 19th, and Srinagar on the 24th. Up to this point there had

been few difficulties, excepting the crossing of unbridged rivers in Afghanistan between Herat and Kandahar. Beyond Srinagar the expedition had to be reduced in size, two tractors only, and without trailers, being taken farther. These machines reached Gilgit by the Tragbal and Burzil passes, with considerable difficulty. They were equipped with material for portable bridges up to a span of 50 metres, and with winches and cables for scaling cliffs and rounding hairpin bends. Nevertheless there were some exciting moments, and on one occasion the tractors had to be dismantled and carried across the broken road by an army of local coolies. Beyond Gilgit, the Hunza gorge at Chaichar definitely prevented further progress, and the party was forced to proceed on foot and pony-back to Kashgar, which was reached on the sixty-fifth day after leaving Srinagar, a journey which is normally a forty-days' march." *Citroën Central Asia Expedition. Review by K.M.* 84.446.

"We reached Kabul at the 297th mile. We had covered 930 miles from Herat, travelling in no hurry; and under perfect conditions this journey could probably be done in eight days. For the first part of the journey we were in a Chevrolet four-seater ("machine-i-sawari" is the newly coined word for such a vehicle) which broke down completely at a caravanserai named after the Moghor district 50 miles before Murghab. The fault of this car when used on these roads was a too low clearance. From Murghab to Maimana we travelled in a Ford car. The rest of the journey was done in Chevrolet lorries which seem the ideal cars for this country, the clearance being sufficient, and the engines giving no trouble. In all we covered 1360 miles in Afghanistan, under unusually difficult conditions, and without any really grievous excess of trouble. Of this distance only 50 miles were covered by horse, which 50 miles, with all respect to progress, were very much the most delightful."

Christopher Sykes. Afghanistan. 84.336.

"One should never have a fixed time for arriving. Before we crossed a fairly deep river, the driver opened the bonnet of his car and wrapped the engine in a large piece of felt he had by him: he then dashed through and just had time to get to the other side before the water penetrated to the engine." *Freya Stark.*

CYCLES

In the African coast lands there are wide stretches where carriers are essential and riding animals will not live. Here a monocycle is of great use. It has one wheel, fitted with a motor-cycle tyre, and above it a comfortable seat; the frame is extended into handles in front and behind for two natives, who can balance the machine and on the level convey the passenger at about 4 miles per hour. In a torrid coastal zone the traveller can arrive in camp comparatively fresh and ready for work, instead of exhausted. Cost about £15.

C. W. Hobley.

I found here three bicycles left by a stranded Circus that went broke and was sold up. These belonged to a trick cycling act and only weighed 14 lb. apiece. They come completely to pieces almost at a

touch by releasing two clips and pulling the tubular aluminium frame apart. They can be packed down into a small canvas bag 28 inches square and any depth according to the number of cycles one puts in one on top of another. The tyres are solid, but their cylindrical springs make even better riding than air-filled ones. There seems to be no limit to the load that can be put on these machines and although not highly geared they can be made to travel very fast over all kinds of country not too mountainous. These things save hours of walking when travelling or collecting. For surveying they could be put to all kinds of uses: small dynamos and things can be run off them; and if one wants to one can always carry them on one's back without any discomfort! Please put this in the *Hints;* I am sure many will bless you! *Letter from Ivan Sanderson from Haiti* 2/8/37.

FLYING

In this book we may neglect the long-distance flight achieved at great risk by bold and expensive organizations, and confine our brief treatment to the value of aircraft in cooperation with land exploration. The aeroplane may prove invaluable in reconnoitring a route, in carrying forward supplies, in saving time by delivering a small party at an advanced base, and in relieving a traveller smitten with illness. Its most essential work is perhaps to obtain oblique photographs of impassable country. But experience shows that an aeroplane may become not so much an auxiliary as the dominant factor in an expedition, altering its whole character.

"I consider the aeroplane ideal for survey work. Still it has its drawbacks: the trouble of finding suitable landing-grounds, 600 or 700 yards being necessary, and the risk of soft patches and anthills; unlike North Australia, where they are high and easily seen, here they vary from 1 foot to 18 inches in height, often hidden in clumps of spinifex. Striking one of these would probably break the undercarriage. In the event of a forced landing in sand-hill country successfully made, after rectifying engine trouble, it might take a month to be in the air again, for a trench 600 yards would have to be cut and filled with spinifex, then packed with sand to make a run-away. This would be a big undertaking, as there would probably be no water within 50 to 100 miles. The ideal expedition would combine aeroplane and camel, the plane to do the survey work, the ground party to examine the country rock, flora and fauna, and to locate rock-holes not discernible from the air."
Mackay. Central Australia. 84.512.

The design of machines changes so rapidly that not much can be said upon choice and maintenance, but adaptations necessary for polar work may be indicated.

THE AEROPLANE USED BY THE B.G.L. EXPEDITION

A machine equally good as a seaplane and as a skiplane, with quickly interchangeable undercarriages, should combine the most essential qualities. First wooden construction: major repairs can be carried out; airframe spares can all be cut straight from suitable timber, even main and tail plane ribs; as robust as metal, cannot corrode, and did not warp. Next essential a quick take-off, both as a seaplane and as a skiplane, slow landing speed, with ability to land in very confined spaces. The pilot must see directly ahead to dodge small pieces of ice or wind drifts. After these come the cabin space, facilities for relieving the pilot in the air, folding wings for convenient housing, general suitability for rough handling, and heating of cabin and cockpit.

The de Havilland Fox Moth had most of these; it had been used successfully in the north of Canada in conditions very similar. Two drawbacks were the very poor forward view the pilot has taking-off, particularly on floats; before every take-off the track had to be thoroughly inspected; and the pilot cannot be relieved in the air nor dual control fitted; the pilot sits behind and above the cabin that is fitted to carry two passengers on a double fold-up hammock seat facing forwards. The forward part of the cabin was adapted for either an Eagle III electrically operated automatic survey camera, or for an additional petrol tank. The normal range of the Fox Moth with 35 gallons of petrol was $5\frac{1}{4}$ hours or 450 miles in still air. This range could be doubled when the take-off was from sea-ice. A 20 per cent. safety margin for petrol was found adequate.

Slight alterations from standard were: all main fittings attached with stainless steel bolts; additional $2\frac{3}{4}$-gallon oil tank inside cabin on port side to allow for use of spare petrol tank; handholds in the bottom plane wing tips for easy handling and tethering; bottom plane leading edges ply-covered, necessary when machine likely to be roughly handled, and since ice thrown up by the airscrew is liable to puncture the fabric; special dope T.5.S for fuselage and all fabric-covered surfaces as recommended by the Titanine-Emaillite Co., extremely satisfactory; the leading edges of all main planes, tail, and fin doped with the same yellow finish as the fuselage to prevent ice sticking to leading edges in flight; provision for lifting the machine with wings folded, for stowage on board *Penola*.

The Gipsy Major 130 h.p. air-cooled engine had an extra fitting to the carburettor intake so that, except at full throttle, warm air was collected from against the crankcase, preventing ice-formation in the intake and choke tube, and allowing the engine to function perfectly in the coldest weather. Apart from this, only standard alterations were made to the engine for use in a seaplane.

except temporary membership

The floats made by the Fairchild Aircraft Company of Canada were composite wood and metal construction with large stuffed leather bumper pads on the nose, very robust for work in loose ice, and beaching on rough pebbles. After three years' use there were still no leaks and very little corrosion.

For winter and spring flying, exposed oil pipes were lagged with lamp-wick covered with insulating tape. An additional heater was fitted in the cabin, drawing hot air from the engine. A 2½-inch by 4-inch channel was fitted to collect hot air from the engine and lead it on to the pilot's windscreen with an additional 1½-inch pipe also collecting hot air from a jacket round the exhaust pipe. By this means the screen was kept clear of frost down to $-20°$ F., but not below. To put one's head outside the screen meant instant frostbite.

Use a motor-boat to tow a seaplane through ice. Float rudders are essential.

Summarized from paper by W. E. Hampton for Polar Record. Contains also a useful section on Tractors.

EMERGENCY EQUIPMENT CARRIED IN AEROPLANE

Summer

Inflatable rubber boat to carry 275 kilos. Inflating apparatus and two light paddles. Made by Albert Meyer, Melchiorstrasse 29–43, Berlin SO 16 ..	36 lb.
Camp and Sports special double tent complete ..	7
24 days' rations at 15 oz. per day, small Primus and cooking pot	25
2 Double down sleeping-bags	5
1 Gallon kerosene and tin ..	10
Air Ministry pattern anchor	25
40 Fathoms 1¼-inch rope ..	17
Boat hook	3
Very pistol and 8 cartridges	5
Box spares and float repair outfit	5
2 Signal flags	½
Total	138½ lb.

Winter

Camp and Sports special double tent complete ..	7 lb.
24 days' rations at 15 oz. per day, Primus and cooking pot	25
Spare footwear and socks ..	3
2 Reindeer fur sleeping-bags	18
1 Gallon kerosene and tin ..	10
4 Mooring bags and rope ..	22
Small shovel	3½
Ice spear	1½
Engine muff and blow lamp	25
Can for draining oil from tank	4
Box spares (plugs, rubber pipe joints, repair outfit for fabric, etc.)	5
Very pistol and 8 cartridges	5
2 Pairs snow shoes	8
Total	137 lb.

The mooring bags were made of No. 1 cotton canvas in Graham Land to suit local conditions: ground area 4×2 feet with sides 1 foot high; opposite corners joined together with 1¼-inch rope, through which a line from any part of the aeroplane could be looped. These bags were designed to tether

the aeroplane on sea-ice when not possible to dig in the skis. Fill with snow or ice and if possible bury; attach one to each wing tip and either one to nose and one to tail, or both to tail. Raise tail to reduce lift of the wings.

On long flights away from sledging depots the ration had extra pemmican to suit conditions. The aeroplane crew carried Kendal Mint to eat while flying: very satisfying and does not cause thirst. *J. R. Rymill.*

"The equipment consisted of two D.H.60x Moths with Gipsy I engines, constructed by the De Havilland Aircraft Co., Ltd. G–AAUR had special locker accommodation for carrying a rifle and all the necessary emergency gear that had to be taken on long-distance flights, also special fittings for taking vertical and oblique photographs. She had two undercarriages: one with floats designed and built by Messrs. Short Bros., which were specially strengthened for emergency landings on snow or ice. Luckily we never had to test their efficiency in this respect. For winter flying she had a standard Canadian type ski undercarriage. G–AAZR was only ordered about a fortnight before the expedition left England, and was standard in every way. She was only fitted with a ski undercarriage. Both aircraft had *coupé* heads, exhaust-heated cockpits, and extra fuel tanks giving an endurance of about seven and a half hours, or approximately 560–600 miles in still air.

During the whole expedition seventy-four flights were made, totalling 86 hours 5 minutes in the air. Of these, twenty-five flights totalling 39 hours 15 minutes were in the summer from the sea, while the remaining forty-nine, of 46 hours 50 minutes, were carried out in winter from the ice. It is of special interest to note that nearly twice as many flights were made in winter as in the summer.

During the winter, except when a gale was blowing, it was found possible to fly whenever necessary, and thanks to the *coupé* heads and heated cockpits no discomfort was experienced from cold even when flying over the Ice Cap. Of course great care was necessary in the selection of suitable clothing.

Before both the northern and southern coast journeys the part to be surveyed was flown over and photographed. By this means it was seen where the existing maps were most incorrect. Any new features were specially noted and the photographs proved most useful to the surveyors for filling in detail. The Moths were also found useful for finding the best way through the crevassed area at the border of the Ice Cap. The above illustrations are taken from the work of this expedition, and are typical of the type of work to which small aircraft can be put.

At the head of the base fjord [in summer] we very seldom had bad visibility, though coastal fog was often visible at the mouth. I can go further and say that we very seldom flew without seeing fog over the pack-ice, though from 100 feet upwards the weather was absolutely clear. Previously all reports have been sent from ships in or close to the pack, or from shore stations close to the sea. We however based at the head of a fjord, and operating with seaplanes were able to see that the fog formed over the pack, and not the coast, and that it very seldom even reached the coast except at promontories." *D'Aeth. B.A.A.R.E.* 79.473, 8, 9; 80.27.

"The aeroplane, which was a Gipsy Moth, was carried on the deck in front of the bridge. When the wings were folded back there was just room

for it between the hatch and the bridge. Even then however the tail projected over the side, and great care had to be taken when passing any large piece of ice."
Stephenson. B.A.A.R.E. 80.2.

"The major flights were eight in number, a depot-laying flight to 85° S., the journey to the Pole and back, a long flight to the north-east to Marie Byrd Land, and five shorter ones to the immediate east and west of the base. The planes landed on an unreconnoitred surface five times without accident.

Nevertheless, in spite of the greatest admiration for the daring and the skill of the pilots one must confess that the same journeys with the exception of the one to the Pole could have been done equally well over the surface, with the forty-two men and one hundred dogs available. The actual sledge journey by Gould used six men and fifty-four dogs, and the journey to Marie Byrd Land could have been made with the remainder of the dogs and, say, four men, while the minor journeys could have been undertaken by man-hauling parties using, say, another twenty men, leaving plenty to carry on the work at the base.

The only superiority which the aeroplane could claim besides its speed would then appear to be its independence of crevasses and its photographic survey, the latter being replaced on the other hand by a much more intensive survey of a narrower band of country. This is not a criticism of the expedition, but an analysis of its results to show that as yet the aeroplane cannot claim to have done better than surface travel for equal expenditure in money and personnel. It will do so in the future of course, for as soon as planes can be landed with certainty on a snow surface their range can be immeasurably increased by a system of fuel depots. When that era comes a system of combined air and surface travel will indeed conquer the Antarctic, but the pioneer expedition of Byrd has shown that it is not yet possible."
Debenham. Review. 78.76.

"The machine would have to be of a type which could be made fast safely to the ice or snow while riding out a blizzard. A low-wing type would serve that purpose, and one without struts or wires attached to the landing gear would best facilitate the lowering of the skis into channels dug in the snow and the digging out of the plane from the snow-drift when the blizzard was over.

In 1931, when my plans were first announced, there was no plane of the type I required, but a canvass of the possibilities showed that a development of the Northrop Alpha plane, a low-wing all-metal machine with cantilever streamlined landing gear, would best suit my purpose. At my request the Northrop Airplane Company built a special machine, the *Gamma*, for my service. It was large enough to carry sufficient fuel for a range of 5000 miles if nothing but fuel and oil was to be carried; but naturally some of my load would consist of equipment and supplies.

The fuselage of the Northrop *Gamma* was large enough to accommodate a pilot and navigator, a sledge, skis and snow-shoes, sleeping-bags, tents, engine covers, and heating stoves required for conveniently starting in cold weather. The machine was of course equipped with a two-way wireless as well as an emergency radio outfit. The final design incorporated a 600-h.p. Wasp engine, giving a possible speed of 215 miles per hour. It had sturdy,

short, and wide skis made of wood, sheathed with metal. The skis were interchangeable with wheels and pontoons, so that we might use the machine on any type of surface. A unique feature was the flaps, a very new feature in 1932 which permitted us to land at the comparatively low speed of 50 miles an hour and take off in a short distance." *Ellsworth. Antarctic.* 89.196, 7.

"It is evident that a long flight with a little ship in drifting ice as a basis is a very hazardous undertaking, since in the event of fog there is a risk of not finding the way back. On the tour southward therefore all characteristic icebergs were sketched on a map so that there would be definite landmarks for the return flight. . . . It had then become foggy on shore, but a short distance out the air was again clear. Course was set towards the point where they had left the *Norvegia*, and they soon recognized various icebergs and found their way to the vessel, which however was only visible through an opening in the fog." *Holtedahl. Antarctic.* 78.410.

The determination of position by sun or star observation is in principle treated in Volume I in the sections on Position Lines, and the utilization of oblique photographs in the sections on Photographic Survey. Here it is necessary to repeat that every camera used for photography from the air should be properly calibrated, that is to say that its equivalent focal length should be measured and placed on record before the expedition leaves, and the plate or film should bear the imprints of fiducial marks which determine the optical centre of the field. Any good photograph taken with a calibrated camera will, sooner or later, be useful for mapping. An uncalibrated photograph is of relatively little value.

STEAM, MOTOR, AND SAIL

Shall the ship be worked by the members of the expedition, or a paid crew? The former is more enjoyable. There is no difficulty about insuring, but a ship's charter usually requires a qualified crew. The danger of former is risk of finding too many of the party ashore and not enough left for the necessary watch on the ship.

Formerly wooden ships only were employed in ice, and a small ship must be wood, but large wooden ships are very heavy and costly to run. The superior power of a steel ship may outbalance the advantage of wood in standing blows. A steel ship specially constructed, double-riveted, with extra power, can shift ice-floes to get out, and trusts to having never to stop. She must have sails as a standby if damaged.

Steam engines have more punch in ice, but oil gives a slightly larger radius of action, is not consumed when at anchor, but is always

except temporary membership

ready. The oil-fired ship may carry only one engineer and run alternate watches with no one in the engine room, all controls being led to the deck.

The cost of a ship per day per head is about the same for big and small ships. The charter should include wages, insurance, food for the crew; charterer should pay for fuel and for extra work by the crew ashore.

Captain of a sealing ship is generally part owner, and will take more risks, though the ship is never fully insured. The mate is a servant and will take no risks.

"We left Aberdeen on 24 May 1934. Our ship was the Norwegian sealer *Heimen*, 129 tons gross, oil-driven and built in 1929 to replace an older ship of the same name. She was captained by her owner Lars Jakobsen, with whose ability as a seaman and ice pilot I was already very familiar, and had a crew of ten all told, made up of two watches each of four men, a cook, and a mess boy. The wardroom party numbered nine."

Wordie. Baffin Land. 86.298.

"At St. John's we were met by Mr. Geoffrey Milling, who acted as our agent in Newfoundland. Mr. Milling, who was a member of the Second Oxford Expedition to Spitsbergen in 1923, was responsible for all arrangements, and these were admirable in every way. The schooner chartered for the voyage to Hudson Strait had already arrived from Port Union, and thanks to Mr. Milling's efforts she was almost ready to sail. The *Young Harp* was a Newfoundland-built ship of 100 tons, with a semi-Diesel engine of 120 h.p. The engine proved to be her one weak spot. She was a comparatively new ship, built in 1927. We had secured the services of Captain Rideout, an 'outport' captain, and the ship was manned by an outport crew. I do not know whether we were particularly fortunate in our choice, but I doubt if any expedition has sailed with a more pleasant or more efficient captain and crew.

Considerable alterations had had to be made on board to accommodate us. The forepart of the main hold was fitted up with bunks and a skylight took the place of the hatches. An additional galley and storeroom, with temporary partitions, separated the living quarters in the hold from the forecastle."

Clutterbuck. Akpatok I. 80.212.

A ship can be insured against total loss, but it is more difficult to cover damage incurred in Arctic waters, such as losing a propeller or a blade, stripping the keel, or damage to rudder. The charter should guard the expedition against liability for damage during its course, otherwise the owners have no incentive to appoint a good captain. The charter should state clearly the expenses for which the charterer is responsible, and a final clause should make the owners responsible for all other expenses connected with, or resulting from

the operation of the ship during the charter, unless the ship is beset during the winter, when the charterer might be responsible for wages of the crew, but the owners receive no charter money after an agreed date: or charter might provide for purchase of ship at an agreed figure.

The crew should have no right to hunt, shoot or fish during the voyage, or time will be wasted in hunting at sea, and scientific work disturbed on shore. Crews may be compensated for losing this customary right by a free ration of tobacco and a gratuity at the end of the expedition. If any hunting is done by the charterers the skinning is done by the crew, who have fat as perquisite.

Emergency stores necessary for possible wintering may be bought and re-sold if in good condition at a discount of 10 per cent., which is a reasonable rate of insurance against wintering.

"In the immediate foreground near Devil's Thumb Island there were considerable water areas, formed not by melting of the ice but, as the angular edges indicated, by the rearrangement of dismembered ice floes. To starboard were level floes of winter-ice and on the port side hummocky floes. We were therefore on our right track, and unless there should be very loose ice farther out to the west would follow this line—between freely moving pack and what is virtually a shore-line of undisturbed winter-ice. In close ice conditions there can be no alternative; it was the whalers' time-honoured route, and for a very obvious reason. Pack moves with the wind, and favourable winds if strong enough must therefore produce immediate open water along this line where one side is bound to remain fixed (unless the land-fast ice itself breaks up), whereas farther out in the pack there can be only fainter chances of a suitable opening taking place at the very spot where a ship should happen to lie. It is in keeping with the more general ice-navigating rule that in close ice a ship should always work along a coast whenever possible, just where wind and tide have most chance of making open water."

Wordie. Baffin Land. 86.300, 03.

For ice conditions on East Greenland coast, see 75.483.

"Early on the fourth day our passage became difficult and it remained so off and on for the five days which followed, until we were clear of the ice. This was for a distance of about 250 miles. The pack was closer than before, with few and narrow leads and a scattering through it of old heavy floes which gave it greater weight; and all was bound together by the new ice, now anything from 6 inches to 2 feet thick. In places this ice was still dark in colour, in others overlaid with light snow. It was not hard, and there was no sharp jar when the ship came up to it, nor did her stem ride and break it; but she was brought up in surprisingly few feet with little progress to show. No long crack opened up through it like the long cracks through thin floes before the stems of ships in polar films. It was tough with a resistance which was almost glutinous.

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We saw, on one of these days, a striking demonstration of the fact that icebergs and pack-ice are moved by entirely different forces, the former, lying deep in the water, by surface currents, the latter by winds. We were indeed held stationary for a short time by the opposition of these two forces, and we had no alternative but to watch and wait. We were in a narrow lead between two large floes. The wind was on our starboard hand, from the ENE., blowing between 11 and 16 miles an hour. Slowly the floes closed in and held us and we could not go on. We found this to be due to a large iceberg, 1 mile long and 120 feet high, on our port hand, on the opposite side to the wind. It was being carried towards us by the current, against the wind and through the pack at the rate of about 1½ knots; in doing so it was closing up and 'pressuring' the pack in a wide arc before it, and charging through it, leaving a broad wake behind. For a time we were within the advancing arc of pressure, but when the iceberg had passed a short distance astern of us we were able to go on again." *John. Antarctic.* 83.389.

"When steering amongst dangers the general rule, always to keep danger in sight—in other words to work with short departures—is strongly to be stressed. It is rash in the extreme to steer broadly down the middle of a channel, hopefully thinking that all is safe. A mast-head man, carefully following close to the edge of a reef, can tell at once if the visibility of reefs changes and coral tends to become dangerously invisible. If courses are made from reef to reef, the navigator always has a good idea of his position and a mast-head man of the conditions.

It is not difficult to acquire a sense of security in working amongst coral. Once acquired, a district unsurveyed and marked as full of dangers is attempted with as much confidence as more familiar waters. In fact, what has to be remembered is that the familiar area must always be navigated with as much care as if it were being entered for the first time. Though coral is rightly regarded as a danger, it need not be inferred that the occurrence of reefs implies dangerous conditions. With skill, the reverse is true. The reefs are magnificent breakwaters, and in hard weather, making use of the shelter they provide, passages can be made in comfort and safety, dodging from reef to reef, that would be miserable, or even impracticable, for a small vessel in the open water away from the reefs."

Spender. Great Barrier Reef. 76.291. Study the whole *Note on the Appearance of Coral Reefs and Navigation amongst them.*

BOATS AND CANOES

Outboard motors

Outboard motors are troublesome but necessary, easily damaged and knocked overboard, put out of action by sea, have no clutch, and in some types when the engine is stopped you cannot steer except with an oar; but they are essential for coastal journeys. Inboard motor boat cannot be beached without a tackle, or easily pulled across ice-floes. If the coast is reasonably sheltered an inboard motor much better.

The outboard motor must work at full or half speed with a two-stroke cycle, but cannot run very slowly. In ice requires great supply of shear pins. Two motors must be carried for a long journey. Aluminium corrodes in salt water, but some machines are made of an aluminium alloy which does not corrode badly. If they can be swung up horizontal whenever the engine is stopped, corrosion is slight. These hinged motors are not damaged if the boat touches bottom. A heavier type of gun metal and brass running slow, reversible, is better in ice, but very heavy. Make petrol supply absolutely sure : slightest trace of water is fatal.

"We had to take with us to Lake Rudolf a boat sufficiently large and sturdy to withstand storms and the heavy swell which is a permanent feature of the open water. . . . With the aid of a considerable number of native Turkana we launched the 20-foot metal lifeboat lent to the expedition by the Government. . . . The site of our base camp had the advantage of being partly sheltered by a sand-spit some 10 miles long forming Ferguson Bay, for the big seas from the south-east present a formidable obstacle to small boat navigation. On one crossing of the lake, for instance, we experienced a swell which we estimated to be at least 60 feet from crest to crest. With the aid of a 12-h.p. outboard motor, which propelled our craft at a speed of 4 or 5 miles an hour, and by picking our weather we were able to visit all the lake shores."

Worthington. Lake Rudolf. 79.276.

"For transport the expedition had one large rather flat-bottomed, blunt-stemmed 'tent-boat' of the characteristic local type, with an awning over the centre and an outboard Archimedes motor.

A smaller boat of the same pattern without a tent was used with a second Archimedes motor on the way up, but proved unsuitable and eventually relapsed to paddles. There were also two native dug-outs or corials, so heavy that they would sink if filled. The larger, with six narrow seats, would hold seven at a pinch, reducing freeboard to almost nil: the smaller held two persons."

O.U.E.C.2. British Guiana.

"A boat of average capacity will carry as crew steersman, assistant steersman, sometimes called 'awkward paddle,' bowman, motorman, and approximately sixteen or eighteen boathands. Apart from engine, etc., the equipment includes steering paddles for the two steersmen, bow paddle and paddles for all boathands, while the following ropes are required: the wapp, of considerable length for straight hauling, the bow brace and the stern line, not forgetting a life line. The bow brace and stern line are of the greatest importance in the negotiation of falls in travelling both up and down stream; in the latter case because it is often impossible to 'run' a fall and the boat must be carefully lowered backwards by the ropes, an operation called 'streaking.' The chief use for these two ropes is in keeping control over the bow and stern when, in the process of the work in the falls, they are frequently subjected to the force of a torrent of water rushing through a channel at an angle to the direction in which the boat is being hauled or lowered. Naturally

the wapp alone could never, in such water, hold mastery over these side rushes, and the boat would easily be swept round broadside to the torrent, heel over, and in no time fill and be lost. . . . At other falls it is found possible to 'steam' them; this requires skill and strength on the part of the steersman and bowman in controlling the direction of the boat and, on occasions, a long and hard spell of fast paddling by the crew to assist the engine, which is itself running at full speed. This is especially the case as the boat comes to the actual 'bump,' which is the name given by the boathands to the actual lip of the fall." *Davidson. British Guiana.* 85.272.

"While at the lake two journeys were made to Central Island, a distance of about 9 miles by water from the Ferguson Gulf camp. The expedition's boat was a Hudson collapsible wooden boat fitted with an outboard motor. For its size this is an exceedingly stable craft, and has been approved by the Air Ministry for use in connection with flying boats. These boats were also used by the British Arctic Air Route Expedition."

Fuchs. Lake Rudolf. 86.119.

"Since the canoe to be used by the party had to be carried on the aeroplane, a type specially designed for this purpose was selected for the expedition. This canoe fits snugly against the underside of the fuselage of the aircraft. It is 18 feet long and fairly narrow, very low, and nearly flat-bottomed. It has a square stern and is built for a light outboard engine. With a minimum of freeboard it will carry a load of 800 lb., and with a light-weight 1½-h.p. outboard engine will make from 5 to 6 miles per hour, according to load and weather. Due to the square stern and the absence of a keel the canoe does not paddle well. A great improvement was made on this canoe by the fastening of strips of waterproofed canvas 2 feet wide to the gunwale of the canoe. The inside edge of this canvas was provided with brass eyelets, so that when loaded the canvas could be lashed over the load leaving an opening for each of the crew. With this arrangement the canoe was made much more seaworthy, and with as little as 2 to 3 inches of freeboard was comparatively safe even in fairly rough water." *Porsild. Canadian Arctic.* 88.7

A clinker-built boat is no good in ice. A carvel-built hunting boat, the usual Norwegian model being about 18 feet long, is best for the Arctic, fitted with Norwegian oars and thole pins and grummets (rope rings). Any boat to be used in ice must be sheathed with copper from the bow to abaft the greatest beam. The *Penola* carried four dories clinker built which were successfully converted to the equivalent of carvel built by building up to a smooth surface with triangular strips of wood and sheathing with copper. Her motor boat was an 18-foot inboard Thorneycroft 9 h.p. carrying a lugsail.

BOATS FOR POLAR WATERS

Lifeboats must be carried by every ship, and may be used for unloading; but if there is room on board to stow a scow or flat it would be invaluable.

Small boats will be required mainly for coastal survey, but also for taking sledge parties to their point of departure, gathering seals, fishing, and towing aeroplanes. Study the type suited to the locality. An ordinary ship's lifeboat can often be had cheaply; but they are very heavy for their size, unhandy to haul about, and heavy to row; they will not sail; and if an engine is fitted, they will need a large one and use much fuel: also the stern post will not be strong enough when bored for a shaft, and anything but a central propeller will be unsatisfactory in ice.

A suitable motor boat is between 19 and 25 feet long overall, depending on space on the ship. Bigger than 25 feet will be unhandy for hauling out. Unless you have the proper lifting gear, have long rope strops to go right round, with removable athwartship spreaders to take the inward stress of the strops when lifting. Have the bows decked in and a bulkhead athwartships, so that one or two can sleep on the floor under cover. See that the forward decking is strong enough to walk on and is not too turtlebacked. A canvas screen called a dodger on top of the forward decking will be useful. Leave as much space as possible open for extra drums of fuel and general gear. Wheel steering is better than a tiller. Have the bows sheathed in copper or, unless the boat is copper fastened, with galvanized iron from the keel to one foot above the water-line and carry it as far aft as funds allow. Paint the topsides red which shows up best. Make sure that the bilge pump works well; a plunger type is generally more reliable than a semi-rotary. Do not have the floorboards screwed down; it may be necessary to get them up in a hurry.

For such a boat there are many reliable inboard engines: between 7 and 12 h.p. will be suitable. The engine must be able to run at very slow speeds for a long time: the slower the better when working in ice. Have a clutch, and gearbox with ahead, astern, and neutral. Six to seven knots should be ample top speed to stem most tides. Do not have a lot of shaft outside the boat; shun V-sterns and shaft brackets.

The maker will advise what are the parts most likely to give trouble; the following spares are the minimum for most engines: One magneto; one (at least) propeller shaft with keys; complete set of spare valves; chains, such as starting chain, timing chain, etc., when fitted; piston rings, assorted washers, nuts and bolts, and plugs in quantity. If funds permit have as nearly a complete spare engine as possible.

For auxiliary power carry oars and sails, preferably a standing lug and jib with a mast stepped in a tabernacle. A mast capable of taking the weight of a man standing on a bo'sun's chair is extremely useful.

when navigating ice; the extra height of even 10 feet allows many a way to be seen, when from the boat itself the ice would seem impassable.

Norwegian whaleboats are excellent, good sea boats, strongly built, and fairly light. They can be driven at fair speed by an outboard engine of 3 to 6 h.p.; may be bought in Norway from about £15; and run from 18 feet upwards. Sheathe as much of the hull as you can afford. A two-stroke inboard engine such as made by Watermota or Britannia Motors could be fitted to give satisfaction; they cost about £40. There is also a small single cylinder Swedish hot-bulb engine, costing about £20 new; they take up little room, run on Sola oil, and can be started in one minute with blow lamp. This latter engine has no magneto to go wrong, is very slow revolving, and extremely reliable; but it has neither gearbox nor clutch, so neutral and astern is done by altering the pitch of the propeller blades; this is unhandy in ice, with damage to shaft and propeller.

Another useful boat is a yacht's dinghy about 8 feet long; one man can haul it up the beach by himself, and it can make short journeys round the base where a bigger boat would be unhandy; an outboard can also be used. Excepting dinghies have boats carvel-built; clinker-built boats will not stand up to ice and are more difficult to sheathe with copper. Avoid metal boats; you cannot repair them without the proper plant. If there is not much room in the ship, a party proposing to spend more than one season in the field might have a boat built with screw fastenings in place of rivets, so that it could be taken to pieces without damage and reassembled during the first winter. A good amateur carpenter should manage this, but unless experienced in boat building should see as much of the original constructing as possible.

Outboard engines between 3 and 6 h.p. give ample power; the lighter the engine which will give say 5 knots, the more handy it will be. Look for a simple outboard, and avoid battery ignition; get an engine running as slow as possible. Aluminium parts are attacked by salt water very quickly, but may be made impervious by cleaning off all grease, polishing the aluminium bright, and applying three coats of brown hard varnish. Dry each coat thoroughly before applying the next; but get an engine made of a bronze alloy if you can, and then it is better treated in this way.

The makers will suggest suitable spares, but you will require a more extensive tool set than that supplied as standard. Be sure to take 200–300 spare shear pins; even if assured that 1 dozen will do. Except when the engine is brand new mix slightly less oil with the petrol than the makers say; then you will not have much trouble with oily plugs. Always carry spare shear pins and plugs; it is easier and

quicker to put in new plugs than to clean them at sea, and the petrol as mixed with oil in the fuel tank is useless for cleaning. Remember that the fewer people run the engine the less trouble it will give.

Minimum gear for a small boat journey is: one light anchor of 30 lb. approx. and one heavy of 60 to 80 lb. approx., not stockless type; 50 fathoms of 2-inch (circumference) rope in one piece; and 10 fathoms approx. of the same, not necessarily in one piece; do not be afraid of having plenty of spare rope: often you will have to moor your boat across a creek. The water in Polar regions is often very deep, you need three times amount of anchor rope as there is depth of water; pieces of old sacking, to wrap round the mooring ropes to prevent their chafing on rocks; tow, to staunch any holes; hammer, nails, and copper tacks; small pieces copper sheeting, to make tingles should you be holed; tallow; blanket cloth, to put underneath copper; tin snips; soldering iron, solder, and flux; full kit of engine tools; funnel for petrol, with chamois leather; a luff tackle, known as a jigger; a sea anchor (if working on an open coast); a compass, Air Ministry P.4. if possible; matches in tins; and portfires.

Keep a few tins of pemmican, biscuits, tea, etc., always aboard as a standby, with a Primus stove and 2 gals. paraffin. The Primus will also be used for soldering. Have lockers fitted and keep a full cooking outfit, pots, mugs, plates, spoons, etc., always aboard; and carry a rifle, shotgun, and ammunition. An afternoon trip of three hours may easily become one of three days or three weeks; ice changes rapidly, fog comes down quickly, gales start suddenly; so always take more clothes than you think you will want; there is nothing so cold as a small boat. Take a sleeping-bag and unless you can sleep all your crew under cover aboard, take the necessary tents to sleep ashore. Remember you are not sledging, so weight within reason does not matter.

Always strain petrol through chamois leather to prevent water going into the tank. Allow, when possible, a 50 per cent. margin of fuel and oil over expected consumption. Always drain the water out of your engine when it is stopped for a long time and the temperature is below 25° F. Keep oars, rowlocks, and anchor ready for instant use; fit your rowlocks with a lanyard, they go overboard very easily.

In Greenland, and when talking to any Scandinavian or German, call petrol (French *essence*) benzine, and paraffin (French *petrole*) petroleum. It is annoying to find a depot of paraffin for an outboard or petrol for your Primus. *Quintin Riley.*

BOAT REPAIRS

All boats should carry at least the following tools and material: hammer; saw; ¾-inch chisel; pair of tin snips; 2 tingles made of

copper sheet 12 by 12 inches, with holes punched closely along the edges; 2 pieces of Fearnought or heavy flannel for putting under the tingles; tallow or white lead; copper tacks; galvanized wire nails assorted; several lengths of board; a boat bag containing palm, and needle, twine, marline, cod line or boat lacing, oakum, and a yard or so of canvas.

With the above gear it should be possible to keep the boat afloat until the base or ship is reached and permanent repairs can be effected.

Serious damage is likely if boats are hauled up or hoisted when they are full of water: they must be bailed out.

For details of repairs read 'Cruising and Ocean Racing' (Lonsdale Library) before proceeding on the expedition. Visit a yard where boat repairs are effected and watch how the work is done; usually the shipwright is very pleased to show the amateur.

Cold climates make wood difficult to bend, and it is useless to try and pay seams that are wet or when the wood is frozen. Use some bitumastic compound such as Righto, which adheres fairly well to wood even when wet.

At the base keep a full set of shipwright's tools: with certain exceptions the same as a carpenter's tool-kit, but should include a set of caulking irons and mallet; set of Whitworth's stocks and dies up to $\frac{3}{4}$ inch; pin maul; set of long augers; hack saw and blades; bow saw.

The material to be taken will vary with the boats in use, but sufficient planking to renew three or four planks in each boat is essential. Take American elm in long lengths for ribs, rubbing strakes, etc.; an oak crook to make a new stem; and material for making new bottom boards; canvas for recovering decks; Fearnought; caulking cotton; oakum; white lead; red lead; marine glue; copper boat nails 1 and 2 inches; copper rooves for the nails; copper rod for bolts $\frac{1}{4}$ and $\frac{3}{8}$ inch; copper tacks assorted; brass screws assorted; lengths of steel rod $\frac{1}{4}$ to $\frac{3}{4}$ inch; plenty of nuts and washers; wire nails galvanized all sizes up to 6 inches; copper sheathing sufficient to renew half the sheathing on the boats; brass sheet up to $\frac{3}{16}$ inch; paint and varnish. *L. C. D. Ryder.*

"On August 15 Lemon, Courtauld, and I started off on the journey to Julianehaab. We had with us two 15-foot whale-boats driven by 4-h.p.

Johnson Sea Horse outboard motors. These boats had belonged to the *Quest*. The bows were copper-sheathed against new ice. The bows of one of the boats were decked over so as to have some shelter for our stores; a mast was also fitted so that we could sail if necessary. We took a large quantity of petrol for the motors, and this occupied most of the space in the boats. Besides this we took three kayaks and all the kayak hunting equipment, rifles, shotguns, and ammunition. We also took two small sledges in case we lost the boats and had to cross the Ice Cap; and winter hunting gear so that if necessary we could spend the winter on the coast. We took some emergency provisions in case we had to cross the Ice Cap, and a little porridge and sugar; but we knew that we should have to rely almost entirely on seal meat for our food." *Watkins. B.A.A.R.E.* 79.468.

"The swell on these steep rocky coasts is so great that the boat must be tied fore and aft to prevent its being battered to pieces against the rock. This meant that each night we had to find a suitable small cove across which the boat could be tied. Unfortunately such a cove rarely coincided with a nearby piece of ground flat enough to pitch two small tents on. Usually after securing the boat we had to climb 100 feet or so up the side of the hill until we found a suitable camp site. The latter term in this country implies a piece of rock sufficiently flat and large for four people to sleep on, without the fear of rolling off during the night and finishing up in the fjord."

Stephenson. B.A.A.R.E. 80.4.

"It was decided that as the proposed journey to Sassen Valley involved the longest open-boat journey, it should be made as early as possible. On July 12 therefore Brough, Robertson, Stott and Glen set off in one of the 18-foot whale-boats fitted with a Seagull outboard engine which had been very generously presented to the expedition by Messrs. Imperial Chemical Industries. After some 10 miles had been covered with a beam sea running, we found that the increasingly heavy sea running up the Ice Fjord from the south would have swamped the boat. This was due partly to the fact that the whale-boat was not decked-in forward and that the engine had been modified to meet the local conditions so that she could only run at full throttle." *Glen. Spitsbergen.* 84.113.

"The general equipment of the expedition was good, except in the matter of boat stores. Sailing conditions in Ice Fjord and Wijde Bay were found to be very good, and properly rigged semi-decked whale-boats would have helped. The outboard engine proved very satisfactory and gave remarkably little trouble. Large amounts of pitch, paint, copper nails, etc., are essential."

Glen. Spitsbergen. 84.129.

"A 9-foot Berthon collapsible boat was used for sounding and occasionally for transport." *Wright. Iceland.* 86.219.

"For boat travel, a 22-foot half-decked launch was bought, driven by a small Seagull outboard engine, kindly presented by Messrs. John Marston of Wolverhampton. In addition there was an 18-foot whaleboat, and a light skiff, as well as two German Klepper canoes used as substitutes for kayaks."

Glen. North East Land. 90.194.

"The boat herself was only a cheap launch. The original hope of a really suitable boat had been vetoed by financial reasons. Built in Tromsö, she had cost only £18; she was certainly unsafe in a storm, and even in moderately bad weather the outboard engine was often swamped by the waves and put out of action. The engine itself however gave wonderful service. It seemed quite happy when spray froze thick on all parts not actually hot. The steering handle was wrenched off, but the boat was sailed with the spanner gripping the steering column. The thrust shoe disappeared, but another was improvised. Over the winter the whole engine was to be buried in a snow drift for six months. On being brought to the base it started at the first attempt without any overhaul or repairs at all. It functioned throughout despite rough usage and bad conditions." *Glen. North East Land.* 90.203.

KAYAKS

The sport of kayak rolling may now be seen from time to time upon the Cam, brought back from Angmagssalik by the B.A.A.R.E. The late Gino Watkins believed that a young Englishman could soon learn to do anything that a native could, and eventually do it better. Determined to live off the country by hunting seals he became skilled with kayak and harpoon; but insisting on hunting alone, so that others could get on with their work, he was drowned by some accident that has not been explained.

"The East Greenland kayak consists of a wooden frame covered with sealskin, usually of the crested or bearded seal. It requires great skill and long experience to make a kayak frame. The young men seldom build their own, usually getting help or leaving it entirely in the hands of an old and experienced hunter. If the curves are not just right the skins will be cut by young ice, or if the proportions are slightly wrong it will be a bad boat in a rough sea. Each kayak must be made to fit its owner, for when one is in a kayak it must be part of one, neither moving independently of the other. If this were not so it would be quite impossible to right the kayak again after it had been capsized, which is actually quite an easy thing to do either with the paddle, harpoon thrower, or hand alone. When the kayak frame is finished the women cover it with sealskin, sewing it with sinew thread and using a waterproof stitch. This is done by passing the needle through only half the thickness of the skin at each stitch, therefore when the thread is pulled tight there will be no stitching visible on the outside of the skin. When the women have finished the covering, the whole kayak is given several coats of blubber to preserve the skins and also to fill up any small holes left in the seams." *Rymill. East Greenland.* 82.539.

"The kayaks which we are using are of the ordinary Eskimo pattern, made slightly larger to fit ourselves. The Eskimos on this coast are generally acknowledged to be the best kayaking natives in the Arctic, so that we have had the best instruction possible. Most European travellers in the Arctic have considered that it would be impossible for a white man to use a kayak or, even if he could use it, to become really efficient in it. We saw no reason

for supposing this to be the case; indeed, we considered that it would be possible for some white men to become far more expert in the use of the kayak than any Eskimo. Ten of us had kayaks made, and for the last month or so have been hard at practice. Already most of us can roll right round under the water and come up the other side, a feat which only about one in four Eskimos on this coast can do. One or two of us can roll right round without using the paddle, which only a few Eskimos here can do."

Watkins. Report B.A.A.R.E. 78.291.

"So for the month and a half before the annual visit of the Danish ship two or three of us went off to an Eskimo settlement about 5 miles from the base in order to learn to use the kayak.

It is a very narrow canoe about 9 feet long, made of a light wooden frame, covered with waterproof sealskin. The man sits in a small circular hole, wearing a waterproof coat of sealskin, which has a hood fastening tightly round the face. Waterproof gloves are worn and the sleeves of the coat fasten tightly over them. The bottom of the coat fastens over the rim of the circular hole in which the man is sitting, so that he keeps perfectly dry, even if a wave sweeps right over him.

About 90 per cent. of the Angmagssalik Eskimo men end their lives by drowning in the kayaks through being overturned by an attacking seal or walrus, or by a wave. A kayak is a tight fit and it is impossible to get in or out quickly. The sensible Eskimos have learnt a special trick which saves them if they are overturned. This trick is to roll right round with the kayak and come up the other side. About one in every four of the Angmagssalik men can do this. Once a man can do this roll with absolute certainty, it means that he is safe to hunt alone, as he will be able to get up again if he is knocked over. I knew that I should have to hunt alone on the coast journey, and I saw that it would not be safe unless I could learn to roll the kayak. It turned out not to be as difficult as it looked, and eventually six of us learned to roll, and one or two of us learned to do it without the use of the paddle (with the hands only). This is much more difficult and can only be done by a few Eskimos, but it is essential for safe kayaking, since the paddle might be lost in a fight with a seal; then, if you could not get up with the hands only, you would drown." *Watkins. B.A.A.R.E.* 79.467.

"Rymill and Chapman were mapping from a motor boat while Watkins was as usual seal hunting alone in a kayak. About 3 p.m., in the middle of the northern branch of Lake Fjord, the motor boat found the kayak full of water with the paddle near by but without the throwing stick or rifle. Half a mile away Watkins's trousers and kayak belt were found on a small floe very close to a large active glacier and at least half a mile from land. Search until midnight and the whole of the following day was fruitless.

A later message says that on the day before Watkins had remarked that the seals were nearly always near a dangerous glacier at the head of the fjord, and his companions suggest in the first message that the kayak overturned while Watkins was shooting or was overturned by ice falling from the active glacier; that he was for some reason unable to right the kayak in the way which he had practised so often with paddle and throwing stick, that he abandoned the kayak, reached the ice-floe, and tried to swim ashore but failed in the cold water." *Geogr. Jour.* 80.278.

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NATIVE CRAFT

"Dhows may be chartered or a passage taken as in any other ship. The cost of chartering a 20-ton dhow for a thirty-hour journey from Seihut to Shihr was a hundred dollars (about £8). Passengers provide their own food. If a dhow is chartered for a long journey it would be possible to fit it up as required. Only the biggest buggalows have cabins. Mrs. Bent in *Southern Arabia* gives a detailed description of how they fitted up a dhow for a long journey." *Freya Stark.*

"Supplies were brought up from Marudi by *prahu*, the ordinary native long boat, usually paddled by twenty or thirty men, but by us fitted with outboard motors, which gave a great deal of trouble."

Harrisson. Sarawak. 82.391.

"Near the mouths of the rivers we were able to hire launches and sampans, but generally we had to make our own dug-out canoes. In each large party of Dyaks there were always one or two experts at this work, and a party of twenty could make three good dug-outs, about 18 feet long, in ten days. A tree of suitable size was felled, and with their bliongs and parangs they stripped off the bark, cut away about a quarter of the tree, and roughly shaped and hollowed the remainder. They next lit a fire inside and out and chopped away the charred part. While the wood was still warm and soft they opened it out by means of a rough framework lashed together with rotan, and stretched it to a better shape. Further shaping and paring then took place, some special small axes of their own design being used. The thickness was decided by drilling holes and using small pegs as gauges. With a few cross-braces, a single rough plank along each side to raise the free-board, and some caulking, a workmanlike and really graceful boat was ready for launching. Our Dyaks used a few nails, but otherwise everything, including the material for caulking, was found in the jungle. The larger boats had cabins roofed with leaves. Some were painted with the most startling designs and had figureheads and charms. In the deeper rivers we used an outboard motor and paddles, but in the shallower and more swiftly flowing streams poles were used, or the crew jumped overboard and pushed. By tying together two to five sampans we made excellent rafts to use in time of floods, and for transporting large quantities of rice and camp equipment."

Bagot. Johore. 83.207.

"I had ordered tankwas, or reed rafts, to be built in Zegi and to meet me near the estuary of the Small Abbai. Tankwas are the only craft plying on the lake. They are made and propelled by Waito tribesmen, who are probably an Hamitic people who arrived on the Abyssinian plateau before the Amhara Abyssinians. The rafts are bundles of papyrus bound together and streamlined into boat shape. They cost eight shillings each and become water-logged in a fortnight. They are heavy to propel, and after a fortnight soon sink if not renewed or repaired with dry reeds. . . . The Waitos punted industriously along the shore following every curve at a speed of one mile an hour. Their only oar is a length of bamboo, and once the tankwa is in deep water, if an unfavourable breeze rises, the raft is likely to be blown 'out to sea,' so they prefer to punt in shallows not more than 12 feet deep."

Cheesman. Lake Tana. 85.491.

CHAPTER X. MARCH AND CAMP ROUTINE

March routine must be based largely on local custom, already studied on arrival (p. 109). Take the best advice on how to deal with local authorities, native chiefs, village head-men, and plan accordingly. Much will depend on local requirements, as that an escort must be taken; on the quality of guides if there are any; on the temper, friendly or otherwise, of the inhabitants; on the precautions necessary against surprise or at least obstruction; and on a thousand things that can be learned only by experience.

"It is customary in these oases, when approaching human habitations in a car, to depress the button of the electric horn and to keep it depressed until the entire population is assembled to greet you, and to answer any inquiries you may wish to make. It struck me at first as discourteous, but I found that this was merely the prejudice of ignorance, and that the kindly peasantry would be hurt by any omission." *Orde Wingate. Libyan Desert.* 83.287.

"Aboriginals in this area are not found in large numbers, and, as a rule, wander in small bands up to half a dozen. Our experience has been that if left alone or made to appreciate during brief periods of acquaintance the privacy of a white man's camp, they give no trouble and are not antagonistic. The only instance of friction was near Sladen Waters in the Rawlinson Range, when on the night of 26 October 1932 two rushed into camp about 8 p.m. and were in the act of spearing O'Grady and me, when our camel boys saw them and gave such howls of terror that they were themselves apparently frightened and deterred from their intention."
Terry. Central Australia. 84.505.

"Such terms as 'hostile natives,' 'savages,' which I have seen in print should not be applied to the natives. Handled in the right way and kept out of one's camp they are certainly a help, not a danger or menace to travellers. Our planes were always left some 200 yards from the camp at Ilbpilla, in the cabin were emergency rations and other goods; but although there were some thirty natives camped in the locality nothing was ever stolen."
Mackay. Central Australia. 84.513.

"Unexpected hostility was encountered at a series of hamlets known as Karakaiya, but calm was restored when it was found that the natives did not interfere with the patrol as long as it kept out of the gardens."
Chinnery. Central New Guinea. 84.405.

"I now made a practice of building a parapet round the camp. This gave the men confidence at night and was useful for keeping the Dankali out during the day. It is the custom for the traveller in these parts to take hostages from the tribe in whose territory he is encamped, only freeing the last hostage when he can induce some one to take his place. In practice of course this system is not always applicable. The chieftain, or *balabat*, who is with you

except temporary membership

stands up as darkness falls and cries out the traditional warning, which removes from the camp all responsibility should they shoot any one approaching during the hours of darkness." *Thesiger. Danakil.* 85.4.

Save disappointment by realizing early that hours of moving, halting and camping depend more on the camelmen or transport drivers than on you. Fall in with local custom as far as possible, though you can generally decide which day to move and which to halt. Make precise plans between the guide and the leader of the baggage train on chosen halts and camping grounds, and give the leader of any detached party full knowledge of intentions.

"Along caravan routes the choice has already been made centuries ago and it is difficult to make the guide camp far from his regular places, which are fixed by necessities of water and fodder. One can, with tact, arrange for the midday halt to be made where one pleases by seeing that the day's fodder is carried from the last night's camping ground. Persians have a natural love for picnics and the beauties of scenery, and can be induced to settle to rest in lonely places more easily than Arabs." *Freya Stark.*

"Where it is not easily possible to get a single man across a torrent a point must be found where the torrent curves sharply, so that the first man with a rope tied to him can be lowered down the torrent to the opposite bank. Having got a man across, a rope was fixed between large boulders. A strong V-shaped juniper root was next found. This was placed inverted over the rope and from it suspended loops of rope in which was placed the load or man. This contrivance was then pulled across the stream, the juniper offering but little frictional resistance. It was in fact a primitive form of the rope and breeches buoy by means of which shipwrecked mariners are rescued."

Smythe. Garhwal. 79.3.

Follow traditional practice in leaving records on mountain peaks or in polar regions, and in the treatment of records left by others. Consider desirability of leaving marks and note of plans to guide a party following, or marks to guide one's own return; give special thought to marking dumps and caches of stores.

"Fearing that we might never be able to find our way without native help back from Tatarii to the highest inhabited village (Nokowula), we marked our route with a multitude of flags, which had been specially prepared for this purpose before we left England. We also daubed tree trunks and rocks with white paint specially carried with us for the same purpose. This gave us a great sense of security when we were left alone."

Baker. New Hebrides. 85.216.

"While sledging to the centre of the West Ice the route was marked at each quarter of a mile by flags alternating red and black. Some of the poles were dug into the snow to a depth of not more than a foot, but despite the fact that 8 feet of pole was showing above the surface, many of them were completely buried by the beginning of the following summer. In case a

party should overrun the station during bad weather, two lines of flags were later set out from it at 45° to the route, red to the north and black to the west. They were little more than 100 yards apart, but so frequent was mist and blizzard that they ought to have been much closer. Once Croft and Wright, while searching for the station in bad weather, came so close that they actually saw the light from the observer's small pocket torch as he took the meteorological readings. Nevertheless they overran the station and it was five days before they finally found it." *Glen. North East Land.* 90.207.

"I noticed that in many places on the Kufra route there were lines of camel droppings that appeared to be of uncertain age. From their numbers however I concluded that they recorded the journeyings of at the least a dozen years. This suggested to me the idea of making blobs of camel droppings at prominent points in the march. My first idea had been to take date-palm branches, like Colonel De Lancey Forth, in his march south from Siwa, but apart from the fact that they are liable to be overthrown, the number available at Mungar was small, even had we denuded the solitary palm there; a sacrilegious act I was loath to commit. My plan worked well enough, but the difficulty was to induce the Arabs to carry a sufficient quantity of droppings." *Wingate. Libyan Desert.* 83.291.

"We camped (Camp 6) on a wide whaleback in the same open wavy country. A note giving the position (lat. $26^\circ\ 28'\ 30''$ long. $26^\circ\ 12'\ 23''$) was left in a bottle on a cairn of petrol tins weighted with sand."
Bagnold. Libyan Desert. 78.23.

Test and record the qualities of guides, especially their powers of keeping direction. Some Arabs in particular have an accurate sense of direction difficult to explain, and worth study and experiment: see Harding King, "Pioneer Desert Exploration," *Geogr. Jour.* 77.541.

"Their sense of direction varied enormously. On one occasion in the Libyan Desert the men in my caravan consisted of three Sudanese camel drivers, a Berberine cook, and an Arab guide. The cook was quite unreliable, being sometimes over 60° in error. The two younger Sudanese were considerably better, though their errors occasionally exceeded 20°. The Arab however had a sense of direction that was almost uncanny. His error hardly ever exceeded 2°, and my head camel driver was little, if at all, his inferior. The guide could not only tell the north, but was able to sight the rifle with almost equal accuracy, so far as I could check him, in the direction of any place that he had visited, even though it were hundreds of miles away in the Sudan and several years had elapsed since he had been to it. Moreover he had absolute confidence in his own powers. When first he saw me using a compass he said that, though he had often heard of these 'machines,' he had never before seen one. He asked me to use it to point out the north, and then altered the direction in which I had laid the rifle to point to what he considered to be the right one. It then suddenly occurred to me that I had omitted to allow for the variation, which was about 4°. On that particular occasion he laid the rifle correctly, literally to a degree. His sense of direction was so extraordinarily keen that he once confided to me, though with some

except temporary membership

diffidence, that he was not quite sure that the Pole Star itself always showed true north, as it seemed to him to lie sometimes too much to the east or west."

Harding King. 77.542.

"In Equatoria it is almost impossible to find out how far it is to anywhere. The answer is always in hours. But we learned great astuteness in turning hours into miles. The method is to have a look at your informant's legs: if they are long an hour means 4 miles; however short they are it is never less than two and a half. The sultan was a very big man, and he told us it was seven hours from his rest-house to the Shari ferry which would take us across to Fort Lamy. The distance by our speedometer worked out at 27 miles."

Tweedy. Central Africa. 75.9.

"Guides were readily available at every village, and the only suspicion of hostility encountered was when a carrier limped up with a bleeding foot which had been pierced by a sharpened bamboo sliver, placed obliquely in a forbidden bypath. He got medical treatment, but no sympathy. He had paid for his curiosity and disobedience of orders against wandering into village precincts which did not concern him."

A. J. Marshall. New Guinea. 89.494.

CHOICE OF CAMPING GROUND

A few general principles are to camp near running water, above a village, not below it; and to see that followers wash their clothes, and that animals are tethered below; to camp out of sight of the village; to camp above valley floors which are liable to flood, to avoid screes and gully mouths and avalanche slopes. Mountain walls bordering active trunk glaciers are liable to rock falls. Consider wind and sun and local weather; whether a site is probably malarial, or infected with bilharzia, ankylostoma, or tsetse fly. Avoid old camping grounds, old village sites, old zaribas for stock, barracking grounds for camels, which harbour pests for a long time.

Never camp in or nearly on a level with the bed of a dry river, which may come down in flood without warning; and always camp on the far side of the bed, or a flood may delay the march. In long grass a large area must be cleared to avoid danger from fire.

In mountains with heavy snowfields above, give particular attention to avalanche danger. In 1936 a hut built by the Ski Club of India at Khillanmarg (10,000 feet) in a place carefully chosen and believed safe was overwhelmed by an avalanche from Apharwat mountain (13,600 feet). A great wind took off the roof of the hut and filled it with snow, smothering three British officers and the *chowkidar* instantly. The snow had flowed like water at least 20 feet deep, down a slope of 1 in 6 for 1000 yards from the foot of the mountain.

"Meanwhile MacInnes and I had left Lodwar for Dome Rock. We had travelled some 30 miles when we were held up by the flooded Lorogumu river. As we reached its bank a storm heralded by an ominous yellow cloud of dust swept up from the south, and a quarter of an hour later the surrounding country had changed from a flat expanse of sand into the semblance of a lake, from which stood out a few drowned bushes. We attempted to return to Lodwar, but found ourselves cut off by a second river that had come down in flood behind us, and only next morning had the water subsided enough for us to resume our return to Lodwar." *Fuchs. Lake Rudolf.* 86.120.

"More difficult perhaps is the establishing of the camps, because you must avoid depressions which are always so inviting but dangerous in case, for instance, of a sudden emptying of one of those numberless lakes which dot the surface of the glacier; neither is it easy to find sufficient space to put up the tents, and it is mostly necessary to level moraine and ice, trying to avoid the too dangerous vicinity of crevasses. But all my camps on the glacier have left in me the remembrance of something supremely and inexpressibly picturesque." *Dainelli. Karakoram.* 79.260.

"In the matter of camp sites we were particularly fortunate; on no occasion did we have to sleep on snow, as a moraine or fairly comfortable talus seemed always available at the proper time. This circumstance meant a great deal, because sleeping-bags remained perfectly dry throughout the trip, and the degree of comfort arising from this helped no doubt to counterbalance the close rationing." *Wordie. E. Greenland.* 75.486.

PITCHING AND STRIKING CAMP

Develope a routine as soon as possible to economize time for travelling and allow time for resting. Pitch your own camp upwind, and your personal servants' camp between your own and that of the main party: the latter in a sheltered place if they have no tents. After tents are pitched, tell off men to cut grass to lay on the tent floor below the ground-sheet, to keep damp from rising. Tell off men to fetch water and collect firewood. In a few days from the start all this should be done almost automatically.

"On top of the rise, end-on to the stream, was the mess-tent, with a main table to seat twelve supported on forked branches with runners connecting them and boards for surface, and two smaller *dabricots*, with smooth sticks instead of boards. On two sides of the mess-tent in the form of an L were the long dormitory tents, differing in having further forked uprights and heavy horizontal runners at about 6 feet along either side for slinging hammocks between. The first, parallel with the mess-tent, held six members of the Expedition, the second five. The advantage of this arrangement, with only a narrow passage to cross between any hammock and the main tent was apparent during frequent downpours. A few yards down the slope was the store tent, with the numbered boxes piled in order on either side of a central alley. Its farther end was the home of Livingstone-Learmonth. Just beyond it lay the Men's Store kept by Sobryan, with Persaud, the other

East Indian, also sleeping in it. Lowest, near the creek, was the taxidermist's shelter, thatched with palm. In a separate part of the clearing some way off, and concealed by large fallen trunks, were the men's quarters. On the other side of the main way down from the mess tent came the kitchen and the photographic *dabricot* in the open, both conveniently between the main tent and the water. The wireless tent lay behind, near the edge of the clearing, and a set of other open or covered *dabricots* served for washing, storing skins and so forth. There were no walls, only tarpaulin roofs, and the rain, although torrential, rarely slanted enough to give trouble. The rebound of the large violent raindrops was sometimes a nuisance." *O.U.E.C.2. British Guiana.*

To water transport at a well or hole, make a trough with a piece of cloth, ground-sheet, or tent over a ring of stones or a hole dug in the ground. Unless the well is shallow or the water-hole deep, pumps will not draw, and are rarely worth carrying. Keep thirsty animals away until you are ready for them; bring up few at a time to avoid jostling and risk of falling in.

In limestone country without surface streams one may carry a small sheet of galvanized iron to collect rainwater, which needs no boiling; but cover the tank to keep mosquitoes out. In extreme necessity remember that heavy dew can be condensed on shiny surfaces like the back of ground-sheets.

CAMP ROUTINE

After settling into camp, inspect transport: if pack animals, go over them and their harness, etc., with senior man in charge of them for sores, sprains, etc., which nearly all native people neglect and treat inefficiently: if mechanized, similar inspection, and give precise instructions or do the job yourself. Hear any requests, etc., by any of the party.

Look into stores and supplies and issue according to arrangements: don't start feeding men, or supplying water from your tanks, if they are supposed to supply themselves. Once you start they will rely on you and take it for granted. Always keep a reserve in case men are in genuine distress, or for emergency. If your men are short of water, give up washing and similar waste of your own, even if the saving is negligible: it saves bad tempers.

Decide early whether or not you are going to move next day: if in doubt never give impression that you may not move: once you have given such impression you will waste much of next day, or all of it. If situation allows, give definite information soon, especially with pack animals that can be given extra feeding opportunities

(taken away for special grazing, etc.). Give such orders simultaneously to personal servant, guide, and man in charge of transport: don't let one tell the other. If moving next day have last two report to you and discuss route, etc., in detail till all three of you know it thoroughly. If midday halt to be made, make sure it is understood.

Once the arrangements are concluded it should be thoroughly understood that no one troubles you till next morning, except in emergency. If possible arrange for definite period of complete relaxation daily before or after evening meal. Take note of followers' calendars, festivals, and fasts, and be prepared to allow some of them as holidays.

At midday, whether long halt or not, read aneroids, and take temperature readings, including wet and dry bulb. On camping set up instruments as soon as camp is settled, not before, or they may be broken. Read at definite intervals without disturbing them. Take temperature and wet and dry bulb reading as near midnight as possible and set up max. and min. thermometers for the night, to be read at dawn, when also use wet and dry bulb again and remember to read aneroids. If night marching take readings at convenient halts. Enter all wind, cloud, and other observations regularly and systematically. *K. S. Sandford.*

"Each under-sardar was given a number of men to serve under him; and before leaving Kampa Dzong each under-sardar was allotted a definite number of store boxes. These boxes were handed over, the nature of their contents explained to the under-sardar; and he was permitted to put his own marks upon them in order to aid recognition. This having been done each man was told that he was personally responsible for his boxes until such time as we reached the Base Camp. During each day's march both he and the men serving under him were to accompany the boxes, and at least some members of each section were never to let them out of their sight. If, as is often the case in Tibet, any particular party of animals was unable to reach camp by nightfall, then the men in charge were also to camp with the transport, sending a man on to the camp to say what had happened. Whenever circumstances permitted under-sardars were ordered to check their boxes daily, and to report the non-arrival of any particular package. During the first few days it appeared likely that we had lost at least a quarter of our entire stores; but a check by various members of the expedition disclosed the fact that this was not really the case, and the supposed losses were due to the sardars' inability to read numbers, or even to count correctly."

Morris. M.E.E. 1936. 89.503.

DATE AND TIME

Keep a standard time in camp and on the march: preferably a time which is if anything fast on local time to promote "daylight

saving." Keep 24 hour time to avoid mistakes between a.m. and p.m. Begin each day's journal with a statement of the day of the week as well as of the day of the month, which is a safeguard against mistakes. In the neighbourhood of the 180th meridian remember the difference of a day between the date carried eastward and westward, but do not be in a hurry to change the reckoning on crossing the meridian. Much confusion has been caused by unnecessary change of date when a party has crossed the meridian with the intention of returning soon afterwards.

"As we were carrying chronometer watches we kept throughout to Greenwich Mean Time; and as locally we were two hours later than Greenwich, we appear to have practised not one but two hours of daylight saving. Whatever the time, therefore, at which we began the day, we were always two hours to the good, and thus benefited generally by warmer hours while on the march." *Wordie. E. Greenland.* 75.486.

RECORDS

Consider keeping the journal in a duplicate book of high-grade paper and sending back carbon copies to home representatives at every opportunity, with a small sketch-map if in unknown country. Avoid abbreviations and the temptation to leave for to-morrow what is essential for the record of the day. Write clearly in moderately hard lead pencil. Record any change of plan on the day it is made, and any delays in the programme.

Write up diary, log of journey, and enter all observations without fail every evening, and make companions do the same. Write the place, date, and hour of each entry. If you put all specimens collected during day on your bed you are bound to pack and label them before you can turn in. Keep detailed log of all photographs, position finding, time signals, astronomical observations and checking of aneroids by hypsometer as necessary.

Suggested arrangement of diary and logs: (1) General account of day's events (valuable afterwards to recall places and circumstances). (2) Scientific or technical observations in another part of diary and under good headings. (3) Tabulated lists of camps and distances and of all readings of recording instruments, with date, place, and times, and weather observations. (4) Similar arrangement for photographs (numbered), remembering to give direction and subject. (5) Keep a private "Who's Who" of all people met, especially of employed personnel and their known family connections, minor officials and others: it may be invaluable at a later date. (6) Start all routine, record-

ing, etc., at least a day before leaving base and continue on day and night of arrival at ultimate destination. Have a stout recording book of which the pages will not rub and so ruin your notes; and a small duplicate book for photograph records. *K. S. Sandford.*

"To express my thanks adequately to Russell and Seaton is a quite impossible task. For weeks on end they laboured every day from 8 a.m. till midnight at subjects that had not previously been in their line, in the unpleasantly cramped surroundings that camp life involve, in order to make by office methods a success of a trip which might easily enough have been carried out only in the spirit of a sporting adventure."

Sanderson. Cameroons. 85.114.

CHAPTER XI. COMMUNICATIONS

THE modern practice of frequent reports by wireless may be essential to finance an expedition, but has many disadvantages. Tends to exaggeration in order to provide news; causes anxiety at home if regular report is not received; and anticipates the interest of proper orderly account on return; makes great anxiety for leader whether to report difficulties, perhaps only temporary, but which may provoke unnecessary organization of relief from home, or on the other hand to incur risk of blame by not reporting at once difficulties which develop into serious danger. Wireless calls for assistance have sometimes caused unnecessary excitement and anxiety, and induced rescue efforts involving further disaster; on the other hand have ensured relief otherwise unobtainable.

"These large expeditions demand of the leader all that he has. Day and night he is as chained to the wireless and it is hardly credible how Knud Rasmussen in spite of it all managed to take as much part as he took in the various endeavours. But it was at the cost of his strength. The modern technique, the relentless *tempo*, the continual change of plans conditioned by radio: all these tired him with their merciless monotony."

Gabel-Jörgensen. 86.481.

"The most instructive part of the whole extraordinary story is the success and the maddening exasperation of the wireless communications. Within a few hours of the crash Biagi was sending and receiving. Almost at once they began to hear the San Paolo station near Rome announcing anxiety at their non-return, and day by day they learned of the tremendous concentration of relief ships and aeroplanes. They could hear also all the messages from the *Città di Milano* both to them and to Rome, and they knew that the search was being directed to the wrong place, but could not make the base ship hear them. The party on the ice came to believe that the ship was not listening for them, but this seems to be refuted by the account of Mr. Odd Arnesen. However that may be, it is admitted that the first to receive their signals was a Russian amateur at Archangel to whom all credit is due for his effective action. On the evening of June 6 Biagi read in the San Paolo evening bulletin: 'The Soviet Embassy has informed the Italian Government . . .' of the mutilated message received by Schmidt on June 3. Next morning they heard the base ship sending them a message, but thought it was for Rome; in the evening they learned from San Paolo that an American amateur had intercepted a message from them giving their latitude as 84°, and this thoroughly upset them. But a little later they heard Press messages from King's Bay saying that the *Città* had received some fragments of their continual call and that they were believed to be in Franz Josef Land—a curious error due to the receipt of the words 'Foyn circa' as 'Francesco." And at

last next evening they received from Rome the news that the base ship had heard them well that morning, and proposed to call them at the fiftieth minute of every hour on 900 metres, whereas they could receive only on 32. However a system was evolved gradually which gave direct communication between the camp and the ship. Every two hours, declares Nobile, the *Città* called them: 'We have nothing new to tell you. Good-bye till the next hour,' and switched over to San Paolo without waiting a moment to see if the ice-party had anything to tell them. 'These words coming so clearly to our ears every two hours seemed almost like mockery.' "

The "Italia" disaster. 76.258.

Radio-transmission requires careful organization for keeping watch at receiving station; heavy plant with skilled maintenance of operation; and is subject to all the risks and uncertainties of short-wave operation.

"Apart from scientific work it was hoped that wireless communications could be carried on daily with the ice-cap stations, three times daily for meteorological purposes, with the Norwegian station on Bear Island, and three times a month both with the Post Office station at Portishead in Somerset, and an amateur station, owned by Mr. Douglas Johnson, in London. This programme was to be carried out with full success.

The apparatus included an Eddystone All World Four Receiver, run off dry batteries, and a Gambrell self-excited continuous wave/phone transmitter, supplied with power from a pedal-driven generator, kindly loaned by Mortley, Sprague & Co., Ltd. This generator was similar to the one in use at the ice-cap station, which however was loaned by Haslam and Newton, Ltd.

This machine supplied both low and high tension, and although it was used every day for ten months, the only fault that occurred was a bad connection in the flexible cable that connected it to the set. The effort required to generate 18 watts at 6 volts, plus 15 watts at 500 volts, is equivalent to pedalling an ordinary bicycle along the level at a moderate speed. The 25 watts high tension required for telephony means pedalling as if going up hill.

The pedal-driven generator is unrivalled for transmitter power supplies at inaccessible places. Dry batteries are both heavy and costly, and will not work in temperatures below −25° F. A rotary transformer might be used, but a windmill generator or small i.c. engine would be required for charging the accumulator. The pedal-driven generator weighs only 50 lb., and is ready for instant use, requiring nothing but a small expenditure of energy by the operator.

The communications with the ice-cap station were carried out on a frequency of 2·0 mc/s per second. The ground wave predominated over the sky wave, and no difficulty was experienced in establishing contact at any time of day throughout the year. The meteorological records were also successfully sent to Bear Island three times a day from September until April, using either 2·0 or 3·0 mc/s, and although the Norwegian station was 300 miles from the site of the base there were few occasions when signals

were unreadable. For direct communications with England however something more powerful was required, this being supplied by a 1 kW. sender kindly lent by the War Office, the power for which was generated by an Austin-7 engine. Press despatches were sent back at intervals to *The Times*, and telegrams could be exchanged with England regularly and rapidly."

Glen. North East Land. 90.209.

Radio-reception is essential for time signals for longitude. Whether receipt of news bulletins, entertainment programmes, and dance music is advantageous on an expedition is doubtful. Some who have used it consider that it is definitely disturbing to the work of an expedition; leads to waste of time and diverts attention from concentration on real objects, besides nullifying a principal pleasure in travelling: being out of reach of the usual interruptions and complications of civilized life. Others consider news bulletins desirable, giving matter for discussion. Probably opinion about equally divided. But to keep a whole crowded hut silent to hear a faint broadcast is tedious to many; better that one man receives the news and posts up anything important for general information.

Intercommunication by radio-telephone between camps is often successful if transport allows supply of necessary accumulators or dry batteries, or if power obtainable from engine of car, motor cycle or outboard motor. Power derived from hand- or foot-driven dynamo often too irregular for telephony, but serves for Morse signalling.

"The requirements were extreme lightness and simplicity. Fortunately these could be met by the use of wireless working on ultra-short wavelengths (5 metres). Fortunately, too, the layout of the mountain is right, for these radiations are very similar to light rays, and require a straight uninterrupted path. Sets were designed by Eddystone with an all-in weight of 28½ lb., and two specially light ones for Camps VI and VII weighed only 15 lb. They could be erected in about three minutes, they transmitted speech, and in use required only the operation of one knob, the send-receive switch.

"When Smythe and Shipton occupied the North Col they found the 5-metre wireless to Camp III as good as a domestic telephone, or so they said."

Smijth Windham. M.E.E. 1936. 89.504.

"Frequent visits were exchanged between Bruce City and Petunia Bay, and a system of signals was also arranged. This was very successful as invariably an ordinary message would be interpreted as a call for a rescue party, and a rapid turn-out would result, much to the gratification of the signallers." *Glen. Spitsbergen.* 82.115.

Organization of posts and runners must be studied locally. Post runners are often remarkably rapid, and faithful to trust, but a

traveller is usually wise to say that his friends must not expect to hear from him. When they do they are all the more pleased.

Every traveller should learn the morse code for signalling by wireless, lamp, or flag. Even very slow transmission and reading may prove invaluable.

Make every effort to verify the accounts, which sometimes seem incredible, of native methods for intercommunication and transmission of news by drumming.

"When I arrived at Botowut, a very long day's walk from the sea, the news was out at once. It was sent in the nicest way news can be sent. A man stood in the centre of six upright slit gongs, from 2 feet to 8 feet high, and with a small log in each hand beat out in tones and times a perfect harmony describing me, my guide, my objective (counting people and talk-talk), calling in every village to see me, to examine my hair." *Harrisson. Malekula.* 88.101.

CHAPTER XII. RETURN HOME

THE returning traveller will be occupied first with seeing his baggage and collections through the Customs, arranging that instruments, undeveloped negatives, and all things delicate and carefully packed shall if possible be delivered at their destination under seal and unpacked in the presence of a Customs examiner in better conditions than can be found at the docks. He will have to produce his papers to show that instruments and cameras, especially those of foreign make, have been taken out from home, having already once paid duty; or to give figures upon which their value as second-hand instruments may be assessed for duty; he may also have to declare whether British instruments have had additions or repairs while abroad. If he has a contract with one newspaper, he will have to escape the questions of the Press generally.

If he has new and original material, surveys, photographs, films, or other things of geographical interest he will communicate at once with the R.G.S. to give opportunity for discussing whether his results may make the subject for a Meeting of the Society and his surveys worked up and drawn by its draughtsmen for publication in the *Journal*; and he will of course avoid offering his material simultaneously to several societies. If he has new geographical names to propose he will lose no time in discussing them and learning to what authority they should be submitted for approval.

NEW GEOGRAPHICAL NAMES

In successive editions of this work the Council of the R.G.S. have urged that before putting forward any personal or fanciful name the traveller should do his best to ascertain that no local name exists, and where none is forthcoming should consider whether one may be conveniently derived from the vicinity, *e.g.* from an adjacent stream or pasture or glacier, or from some characteristic of the natural object itself; that no one should commemorate himself; and that any new name should be put forward tentatively and subject to the approval of the administration of the country concerned.

On the Himalayan borders and in adjacent territories genuine local names for mountains are hard to come by; the Survey of India

have not accepted personal or fanciful names used by explorers in their narratives; and within the last few years took to discouraging well-meant attempts to manufacture native-looking names by writing some of them in inverted commas.

In October 1936 the Surveyor-General of India addressed to the R.G.S. and to the Himalayan Club an important letter on the future policy of the Survey of India:

"As you are perhaps aware, the question of the entry of names invented by explorers and others for peaks and other features of the mountain systems to the north of India on maps published by the Survey of India is one on which there has been occasional controversy.

The practice of the Survey of India in the past has been that no names should be entered on its maps, of areas for which it considers itself responsible, unless they have been found to be of local or at least indigenous origin. It has admittedly departed from this practice in the case of Mount Everest, but it will be generally agreed that the highest mountain in the world is entitled to special treatment, especially when the result was so euphonious. In the absence of a local or indigenous name, the old practice was to allot a symbol, usually a letter and a number. This practice has, however, been abandoned on our maps for many years except in the case of K^2 which, as probably the second highest mountain, is perhaps also entitled to special treatment.

This practice has had two results, one favourable, the other unfavourable. The favourable result is that there has been no temptation to give personal names to peaks, the embarrassment of selection of the person to be so honoured has been avoided, and the situation, not unknown, of the name of a peak being changed because the reputation of its owner had lessened, has not occurred.

The Survey of India will always be grateful to its predecessors for this result.

The unfavourable result is that owing to absence of local or indigenous names in these sparsely inhabited areas our maps are undoubtedly deficient in names. With the ever-increasing growth of Himalayan travel this defect is becoming of increasing prominence.

The position has therefore been examined, and it has been decided that the embargo on invented, other than personal, names, should be removed.

Invented names will be accepted by the Survey of India for its maps taking into consideration the following points:

(i) Lack of local names in the vicinity.
(ii) Suitability of the names.

(iii) When applicable, the degree of currency among climbers and explorers that they have already obtained.
(iv) Personal names will not be accepted.

Suitability is difficult to define, but entirely fanciful or humorous names will not be acceptable. Well-known English names of peaks, such as those in the Karakoram and the Sikkim Himalaya, will be considered for adoption at once.

You will no doubt agree that this change in policy should be brought to the notice of travellers, and I would request your assistance in doing so, either by publication of this letter or by a reference to its contents.

The Survey of India will be grateful to past, present, and future explorers for any suggestions they may care to make. As regards the language of the names we should prefer that English names be confined to the more popular climbing centres. In the lesser-known regions explorers are requested to suggest names freely after consultation with their local guides or coolies—Nalas, cols, glaciers, and peaks may be named after some local pasturage or other existing name, or may be invented with reference, say, to shape, colour, or some other distinctive feature. Such names should normally be given in the local vernacular and should be pointed out to the local people so that they may the more rapidly gain currency. English names should be given sparingly in areas which are likely to be unimportant from a mountaineering point of view.

Explorers are requested to report their proposed names with sketches or annotated copies of Survey of India maps to me either direct or through you. In sending in reports full details should be given of the reasons for the proposed names, with meanings in English, and the local language adopted."

The words *local vernacular* are important. In an uninhabited area, such as parts of the Karakoram, the use of Balti or Ladakhi should, of course, be preferred to the language of Kashmiri shikaris or Darjeeling porters.

"When an uninhabited region is studied in detail by Europeans they must have some way of referring to familiar peaks and passes. Sound opinion has rejected the fanciful names Bride Peak, Golden Throne, and Staircase used for want of better by Sir Martin Conway, and the personal names proposed by Mrs. Bullock Workman. When Mallory discovered the beautiful mountain west of Mount Everest now called Pumori on the maps of the expedition, he desired to call it Mount Clare, after his daughter. This could not be allowed, but 'the map-makers in London, with the aid of a Tibetan linguist,' invented the name Pumori, the Daughter Mountain, which fulfilled in spirit Mallory's intention. This was their happiest effort. Other peaks in the

neighbourhood were called Pethangtse, Khartaphu, Khartachangri, not, if we recollect aright, by the geographers in London, but by Colonel Howard Bury in the field: peak-names fashioned on the analogy of Longstaff's Teram Kangri by annexing the Tibetan for peak or snowy mountain to a district name. There remained for treatment the principal summits on the Mount Everest massif, the South Peak, the West Peak, and the North Peak as they had been called provisionally. These were translated into Lhotse, Nuptse, and Changtse." "*The Designation of Himalayan Peaks.*" 85.73.

A second kind of difficulty is found in Greenland and in Spitsbergen, where names personal or descriptive in many languages have come into use before the establishment of settled administration, superseding in Greenland the native Eskimo names which have peculiar difficulties of their own.

The Danish Government have now established a Committee on names to be accepted for the maps of Greenland, and have laid down the way in which they shall be submitted for approval:

The Director of the Greenland Administration and the Director of the Geodetic Institute are members. The names upon the Geodetic Institute maps of the west coast have been adopted by the Committee, and the names on all future maps published by the Geodetic Institute will be considered before publication and adopted, so that they can be recorded as final.

The Director considers it very desirable that a traveller who wishes to propose new names should submit his proposals to the Committee. The Danish Government has officially informed the British and other Governments that no new names in Greenland will be recognized by the Danish Government unless they have been approved individually by the Committee. Several expeditions which have recently worked in Greenland have already proposed to the Committee new names which have been adopted, and the Greenland Administration now always informs the leader of an expedition going to Greenland that if he wishes to propose new names the suggestion must be forwarded to the Committee at the address: Statsministeriet, Copenhagen." 85.463.

In the Antarctic, with no permanent inhabitants and no local language, with a geography far from precise, its outlines sometimes sketched only from the air, there is some inevitable confusion and overlapping of names. A colonial Office Committee has been formed recently to consider names in the sector of the Falkland Islands Dependency, and proposals for new names should be made to them.

New names proposed for discoveries in the Crown Colonies are

submitted by the governments to the Secretary of State. Of the self-governing Dominions, Canada has a Geographic Board to decide upon spelling and choose between rival names, on the same lines as the United States Geographic Board (now the Division of Geographic Names, Department of the Interior, Washington, D.C.), which publishes from time to time lists of its decisions, and lays down also the spellings of many foreign names for use in the public service.

"The native names Kaieteur and Amaila were obtained by Mr. Barrington Brown, who discovered these falls in 1870. A note on the discovery with pencil sketches of both falls, was published in the *Journal* for November 1932, vol. 80, p. 436. In directing that a report announcing the discovery of the Marina Fall should be sent to our Society the Secretary of State for the Colonies intimated that he was not unmindful of the principle that in general it is preferable that geographical features should bear native names, but having in mind that precedents existed for giving non-native names to other well-known waterfalls, he decided that the circumstances of the case required that attention should be paid both to the compliment intended by the name proposed, and to the loyal sentiment which actuated the suggestion. The proposal having been accordingly submitted to Her Royal Highness, and graciously accepted, the Acting Governor of British Guiana was so informed (*Geogr. J.*, March 1935, vol. 85, p. 300).

In the papers printed above there are names suggested and used without further ceremony for the new falls, which may be considered a little out of keeping with the first three. One is also ambiguous, but it appears that the name applied perhaps temporarily to the new fall 2 miles north-west of the Marina Fall is the abbreviated Christian name of its discoverer, the enterprising pilot who has been operating in British Guiana since November 1934. We are informed that the naming of places in the Colony is not ordinarily subject to any authority, but that it is legally compulsory for every prospector who pegs a claim to give the creek a name, and that a semi-official publication even provides a list of short names, from Ass to Zeus, considered suitable. Most of the names however die with the workings, and the position of the place to which each has been applied is often not known within 10 miles. It may be thought that the time has now come when authority should intervene in the naming of all major geographical features, if not of mining claims."

86.522.

"Besides this, countless rivers and streams are shown, all painstakingly assigned high-sounding names. I can however state with absolute certainty that with the exception of some dozen large rivers, not one of these names exists or has ever existed except on Moisel's map. Even such exceptions as Bali, Munaia, and Mainyu are merely local words for 'water,' 'big river,' 'little river,' etc. It is the same with mountains, even if very prominent; thus Nda-Ali means 'abode of ancestors.' Upon inquiry in Asumbo as to the name of several peaks towering around Tinta Valley, we extracted two names for all of them. It then transpired that both words meant 'hill,' one of them

being literally 'large hill' and the other 'larger hill.' This is perhaps not surprising in a country where the inhabitants recognize only three colours—black, white, and red.

Mamfe Division was first colonized by the Germans at the beginning of this century; it was mandated to Great Britain after the World War. Only two maps in existence approach reliability: (1) Nigerian Ordnance Survey 1924 (sheets 11 and 15); (2) Karte von Kamerun bearbeitet von M. Moisel 1912 (sheet F.I.). (1) is accurate for rivers and contours except in the extreme north; (2) has great detail, remarkable accuracy in place names, rivers mostly hypothetical, and a great number of rivers and mountains shown by names which do not now and never have existed. A careful comparison between the 1912 map and conditions to-day reveal the fact that places do not change their names, nor the villages alter their positions so frequently as supposed."

Sanderson. Cameroons. 85.116, 35.

"Unknown River is not satisfactory, but we have written it provisionally because the trappers now know it by that name. Mr. Frissell proposed to call it the Grenfell River, but we have hesitated to follow his suggestion because it seems to be really the principal branch of the Attikonak. For the five lakes which we have lettered A to E it will be desirable to find Indian names, and preferably to give Indian names also to the Upper and Lower Falls and to Falls X, as well as to the new branch of the Unknown River, on which X Falls are situated.

Locally the Ashuanipi is often called the Petitsikapau, because it comes from the lake of that name, and the branch of the Attikonak which comes from Lake Ossokmanuan to Sandgirt Lake is called locally the Seven Islands River, but only because it is on the route from the Grand Falls region across to Seven Islands Post on the Gulf of St. Lawrence. It should be noted also that locally the Hamilton River is always called the Grand, and the name Hamilton would not be recognized by the trappers."

Watkins. Labrador. 75.112.

THE P.C.G.N.

The Permanent Committee on Geographical Names for British Official Use was established at the suggestion of the Board of Admiralty in 1919 to bring some system into the official spelling of of geographical names. Its published lists, which may be bought from Stanfords or Sifton Praed, or from the Secretary P.C.G.N., care of the R.G.S., are general and special. The first contain important names often spelled wrong, with indication of pronunciation, and equivalents in different languages. They allow conventional forms, such as Leghorn for Livorno, but tend to discourage them. They accept the national spelling wherever the Roman alphabet, however modified by diacritical marks, is used, but transliterate from non-Roman alphabets by the system known as the R.G.S.II, whose principle is that vowels are pronounced as in Italian and con-

sonants as in English. Lists in the second category are for individual countries, dependencies, or mandated territories, in which names have been extensively changed since the Great War, as in Czechoslovakia and Yugoslavia; or have required reduction to consistency, as in Palestine and Iraq; or have only recently come into use, as in Somaliland. These lists are officially revised by the responsible Governments before they are published.

"The names on the map and in the paper have been spelled according to the decisions of the P.C.G.N., made on the authority of the Somaliland Government. The authors protest that some of these names are inconsistent with the results of their own studies on the ground, and would like us to adopt their alternative spellings. This we have been unable to do, being bound to follow P.C.G.N. decisions except for grave cause. The proper course seems to be to follow the P.C.G.N. lists in map and paper, but to submit in this Appendix the author's proposals for the favourable consideration of the Somaliland Government."

Note on the spelling of names by the Ed. G.J. 78.112.

"The spelling of the names in Mr. Halley's paper has been assimilated to the maps of the Survey of Iraq. The spelling differs a good deal from that used upon the earlier degree sheets of the Survey of India. Those names used by Mr. Halley which do not appear upon the Iraq map have been printed in italic, since it is probable that in some cases they represent a phonetic rendering of the local pronunciation rather than a transliteration from the written word."
Ed. G.J. 86.158.

The spellings are now widely used, and the traveller should, when he writes his paper for the R.G.S. or publishes the book of his expedition, either adopt them, or show good cause for differing from them, and do so consistently. The decisions of the P.C.G.N. must often in such a tangled subject be compromises, and when they are transliterations from the written form they often do not represent the local pronunciation. A traveller with knowledge of the language and a good ear will do well to spell as in the P.C.G.N. lists, but give a list of important names as he hears them spoken, written by the R.G.S.II system.

This system serves two purposes: the first, relatively simple, to provide the means for setting down phonetically names which are heard spoken but which have not yet been reduced to any standard form of writing; the second, much more complex and affected by compromises and exceptions, to explain the pronunciation of names which are written in Roman characters but pronounced otherwise than as Italian vowels and English consonants, and to transliterate

names written in non-Roman characters, as Greek, Russian, Arabic, Chinese.

For the first purpose we may simplify the published system thus:

Vowels

a	long and short as in *lava*	Somali; Ababa
ä	between *a* in *fat* and *e* in *eh?*	
e	long as in *eh?*; short as in *bet*	Gelo; Mafeking
i	long as in *marine*; short as in *piano*	Fiji; Kibonde
o	long as in *both*; short as in *rotund*	Kigoma; Honolulu
ö	as in German; nearly the English sound in *fur*	Barköl
u	long as in *rude*; short as in *pull*	Zulu; Ruanda
ü	as in German, or the French *u* in *tu*	

Two vowels usually as a diphthong

ai	as in *aisle*	Wadai
au	as *ou* in *out*	Bauchi
aw	followed by a consonant or terminal, as in *awl* or *law*	
ei	as in *rein*	Beirut
oi	as in *oil*	Hanoi
öi	as in French *oeil*	
ou	separate vowels, not diphthong	Yaroua

Consonants

b, ch, d, f, j, k, l, m, n, p, r, sh, t, v, w, x as in English

c	not used except in *ch* as in *church*	Chad
dh	for the soft *th* as in *they*	Hadhramaut
g	hard as in *gift*; never soft as in *gin*	Gedaref
gh	soft guttural, the Arabic *ghain*	Baghdad
h	only when sounded, or in the compounds ch, dh, gh, kh, sh, th, zh	Ahmadabad
kh	hard aspirated guttural as in Scottish *loch*	Khan
ng	as in *van-guard* or in *sing-er*, distinguished if necessary by hyphen	Ngami, Tong-a
ngg	as in *finger*	Yanggang-a
ph	as in *loophole*; never the *f* sound	Chemulpho
q	only guttural, Arabic *qaf* of Hebrew *qof*; never *qu* for *kw*	'Iraq
s	as English *ss* in *toss*; not as in *please* or *pleasure*	Masikesi
sch	as in *discharge*	
th	hard as in *thick*, not as in *this*	'Athlith
y	always a consonant as in *yard*; never a vowel as in *very*	Kikuya
z	as in *gaze*, not as in *azure*	
zh	as the *s* in *treasure* or the *z* in *azure*	Zhob

Double a vowel or consonant only when the sound is distinctly repeated. Avoid accents except the acute to indicate stress when required. Use long and short marks over vowels only when required to show pronunciation. Indicate the liquid or palatalized sounds of the consonants d,l,n,s,t by adding y when followed by a vowel, and by the apostrophe ' when followed by a consonant or terminal. For the indeterminate or neutral vowel sound, as the *a* in *marine*, *e* in *often*, *i* in *stir*, *io* in *nation*, *o* in connect, *ou* in *curious*, *u* in *difficult*, write *a* generally as in *Basra*, but sometimes *e* as in *Meshed*; and to distinguish it when necessary print the vowel in italic.

The same system is used to show the pronunciation of foreign alphabets in the lists of the P.C.G.N. and in the *Alphabets of Foreign Languages* (R.G.S. Technical Series No. 2), but with exceptions required by long usage, as in the transliteration of Greek (*e.g.* Paphos, not Pafos); or by convention (*e.g.* Calcutta with *c* hard and Celebes with *c* soft).

"Place-names were a heavy task. We had 1500 of them. For ordinary British purposes spelling was required under the R.G.S. II System; but the Commission's official language was French and a French version of the names was therefore required. This has forced on us the preparation of a gazetteer with the equivalent spellings. In some areas it was very difficult to ascertain place-names, different guides having quite different ideas. Another trouble arose from the frequently apparent indifference of the Somali in the matter of choice of vowels; in general we worked by the meaning and, for the sake of consistency, ignored minor variations of pronunciation. The Somali language belongs to the Arabic group, though quite distinct from and with a greater variety of sounds than Arabic. The R.G.S. II System consequently is easily applied." *Clifford. Brit. Somaliland-Ethiopia Bdy.* 87.299.

"*South Arabian Nomenclature*

The names mentioned in map and paper are those in use by Bait Kathir Arabs, thus when these names are not Arabic in origin, they are Arabicized. The pronunciation has the following features:—Z has often the value of the Arabic letter *Sad* (ṣ), *e.g.* Shazar = Shaṣar; Q has invariably a G value, *e.g.* Qarn = Gerin; J sometimes has a G value, *e.g.* Nejd = Neged; D has often a T value, *e.g.* Gasad = Gasat, Sadh = Sath; final B, L, M, and N are so clipped as to be almost unheard, *e.g.* Dhahibū(n), Samha(l), Qata(n), al Gha(b); initial DH has a lisped L sound, *e.g.* dhabb (lizard) = labb. Some of these features, notably the last three mentioned, would appear to show that place-names having such peculiarities probably belong in origin to the Hadara dialects. Ba is the local equivalent of Abu.

Names of places where water collects are often Bin (literally son), Banat (wadi tributaries are always so designated). Literally the Hadara equivalents of Bin and Bint are Bir and Birt: sometimes the B is elided and they become ir and irt. Bit (= Bait) for tribal sections. The Arabic or Arabicized place-names are not used by the bulk of the population, who have their own Hadari

words, hence many places have three or four different designations in accordance with the local tribal tongues." *Thomas. Rub' al Khali.* 77.28.

THE BOOK OF THE EXPEDITION

Most expeditions expect that the narrative of their adventures will make a book that will be acceptable to publisher and public, and have not often in recent years been disappointed. A payment in advance of royalties may have been an essential part of the finance. It is well to take advice on the terms of the contract, and to insist on a clause in the agreement with members of the expedition that no book shall be published by any other than the leader, or some one authorized by him, within a stated period after the return of the expedition—two or three years.

The narrative should be in general written by the leader; appendices by members of the expedition with special interests often add much to its variety and value. It is perhaps almost as important not to overdo understatement as it is to avoid exaggeration.

Essentials in a good book of travel are an orderly development of the narrative; a clear statement of the date in the margin or the running title; a suitable map and diagrams; an adequate index. An agreement with the publisher should provide that his statements upon the dust cover shall be submitted to the author for approval (or he may find Szechwan or Kulu described as Tibet the Mysterious).

A traveller who reads a paper on his journey to the Royal Geographical Society has the advantage that the map prepared by the Society's draughtsmen to illustrate the paper when published in the *Journal* can generally be made available afterwards to the publisher in his book, thus avoiding the greater part of the cost of an adequate map. The author might very well stipulate to the publisher that he should arrange with the Society for this reprint.

"Watkins worked on original lines: as a leader he kept his men together by comradeship rather than by subordination, and there was a pleasing absence of the usual restrictions as to the rights of the leader to exclusive authorship. It was expected merely that no member of the expedition other than the leader should publish a personal account until a year had elapsed after the return of the party." *Review by H. R. M.* 80.523.

"It is only in J. M. Scott's treatment of the journey over the Ice Cap to Ivigtut that we find clear details of the date and distance of each day's journey in tabular form, and this we should have liked to see extended by the addition of columns of temperature and altitude. Such tables are of more permanent

value than descriptions however pictorial, and without them one cannot compare the performances on the various land journeys of this expedition with others in the past. . . . An official account differs from a popular narrative mainly by its claim to permanent value. Such records of past achievement are the material from which plans for future work are made, and their contents should be made accessible by every device of classification and indexing."

H. R. Mill. Review of 'Northern Lights.' 80.524.

CHAPTER XIII. PHOTOGRAPHY

In this chapter we assume a general knowledge of the technique of photography, and deal mostly with the requirements of work in the field and choice of apparatus for the special needs of the traveller: first the larger cameras of the older types, on tripods, and using glass plates, for leisurely work; then the hand cameras using films, and developing into the self-contained miniature cameras. An attempt to classify many cameras now on the market has led to a study of apertures, shutter speeds, and emulsion speeds which has a certain numerical charm and may be useful to others than travellers. The especial interest of colour photography demands a large share of the space. In the brief section on cinematography we deal only with 16 mm. film, leaving aside the standard 35 mm. film as too cumbrous and sound recording as too complicated.

SELECTION AND CARE OF APPARATUS. *By C. J. Morris*

The most useful and effective size for scientific work is Quarter Plate or $4\frac{1}{4}$ by $3\frac{1}{4}$ inches hand-and-stand camera fitted for use with tripod and having the following movements: double extension best quality leather bellows; rising and falling front, and also swing front; reversible back, to take vertical or horizontal pictures without removing camera from its tripod; ground glass focussing screen and focussing cloth; double plate-holders, preferably of metal, and if of wood, reinforced so as not to split or crack: not less than 1 dozen. Take also a quarter-plate Reflex camera, fitted for tripod.

If both cameras are the same make plate holders can be used with either. Both cameras should be either "Tropical," that is of seasoned wood with metal bindings, or else entirely of some metal such as duraluminium. The latter are expensive, and except in quite exceptional damp and heat the ordinary tropical models will give satisfaction.

Fit the hand-and-stand camera with an anastigmatic lens such that one half may be used alone, to give a longer focal length, and make pictures of two different magnifications with the one lens. Mount all lenses in automatic shutters: and also fit both cameras with focal-plane shutters, making it possible to continue work if one shutter breaks down, the most common accident in the field, particularly in tropical climates.

except temporary

A 10- or 12-inch anastigmatic telephoto-lens may be mounted in an automatic shutter, with the lens panel so constructed that the lens may be used in either camera. Include also a wide-angle lens if much architectural work is likely. It will be useful in taking the interiors of narrow caves and buildings, or in restricted mountain districts.

Fit all lenses with filters mounted in optical flats. It is possible to use one set of filters, with a spring mounting, in all the lenses, but preferable to have separate ones for each lens, mounted to screw into the lens cone. Use the filters recommended for the selected plates or film. For normal work two filters will be necessary, increasing exposure about three and six times respectively. Special filters, *e.g.* dark red for snow-scapes, or Aero for air photographs, may be necessary on occasions.

Number each exposure and enter full particulars in diary. Number each negative, in ink if possible, in one corner to correspond with the diary number, or it will be almost impossible to identify many photographs at the end of a long journey.

Aim first at technical excellence; then artistic merit. Mountain scenery is best taken in the early morning or late evening; once the sun is well up there is no light and shade. In general landscape photography usually have the sun directly to one side; but excellent pictures may sometimes be obtained when the camera is pointing directly towards the sun. Protect the lens from the rays of the sun by a lens hood or by a hat held above and in front of the camera.

Portraits are best with the subject entirely in the shade, and an unobtrusive background out of focus behind. Photographs of ethnographic types should be a true front view; a profile; and a three-quarter view: the first two full length, the last a close-up of the head and shoulders only. Focus on a particular point, *e.g.* the eyes in full face, the nose in profile.

Carry either in strong leather cases or in portable airtight metal boxes; in either case fitted with broad leather carrying straps and good locks.

For repairs in the field take: a small packet of graphite for lubricating shutters; a few small brass screws of the sizes used in the cameras carried; court plaster for repairing pin-holes in bellows and blinds of focal-plane shutters; a reel of adhesive tape; a bottle of finest machine oil; a small combination tool, *i.e.* screwdriver, hammer,

etc.; spare ground-glass screens for all cameras; a few yards of butter muslin, to cover negatives when drying.

In the tropics during rainy spells, and at regular intervals, thoroughly dry all cameras with leather and wooden parts. Remove the backs and lens panels of stand cameras to allow the free circulation of air, and open the leather bellows to their full extent so that any mould may be removed. If in reflex cameras the wooden framework swells and makes the shutter stick, a thorough drying in the sun will usually cure it. Rub a very little light oil or graphite into the working parts. Open the camera carrying-cases and dry in the sun. Metal cameras require practically no attention beyond an occasional wipe with a dry cloth. Clean lens surfaces occasionally with a clean silk rag, or better, with the materials supplied by makers. Between-lens shutters may sometimes stick, and may be carefully lubricated with a very small quantity of graphite on a camel-hair brush. For work in intense cold, or in sandy desert country, one may remove all traces of oil from the working parts of shutters and other mechanism and lubricate with graphite only. In desert country wrap cameras in several thicknesses of material such as oiled silk before putting in their cases, to prevent sand getting into the working parts. In very cold countries cameras, lenses, and plates are liable to frost or dew over if taken inside warm huts.

KINDS OF CAMERAS. *By Michael and Humphrey Spender*

Hand-and-stand cameras were the standard instruments of the serious photographer ten years ago. The best lenses were available for them, and they took the greatest advantage of the available photographic material. By the nature of their construction their focal lengths were longer and, since increased aperture meant loss of depth of focus, there was little tendency to develop wide aperture lenses. They were made therefore to work on a stand, and together with their accessories were a weighty addition to the equipment of the traveller.

The Sanderson, the "Una" by Sinclair, and cameras by Adams are all good representatives of their type. The Quarter Plate models range from about £20. They are almost always used with plates.

Amateur cameras met the demand for a cheaper camera for general use. Roll film first, and film pack later, provided a more suitable

material than plates. At first the aperture was small and the lenses of inferior construction. With improved construction, and faster better lenses, the negative size was reduced, first to 6×9 cm. then smaller to $4 \times 6\frac{1}{2}$ cm., and even to the semi-miniature $4 \times 3\frac{1}{4}$ cm. Photographs from these small cameras are enlarged as a matter of course. The whole equipment is lighter but can be considered best as a compromise between the old-fashioned camera and the full miniature camera, with an equivalently compromised performance. There is not the advantage of interchangeable lenses, but the first cost is often much lower than in either of the extreme groups. Lately these cameras are developing into reflex types, to be described in the paragraph below.

The amateur type camera uses sizes from $\frac{1}{4}$ plate film or film pack downwards. There are some excellent tropical models by Adams, Thornton Pickard in the larger sizes at about £20. The cheaper makes will however endure much rough use: all camera makers have examples.

Press cameras have the advantage of a direct wire-frame view finder, large aperture lenses, and focal-plane shutter. They work with plates of fairly large size. But the general characteristics do not make them suitable for expedition purposes.

Reflex cameras. The old-fashioned large reflex camera, formerly much used for nature photography, has been replaced by the miniature camera with its interchangeable lenses. The lack of depth of focus is under certain conditions—for portraiture, for example—an advantage, but is otherwise a great handicap. In this older pattern of camera a dropping mirror enabled the same lens to be used for focussing as for photography. The modern development is the twin lens reflex with 6×6 cm. film. Of all cameras it is the easiest for the uninstructed to use. A duplicate of the lens used for photography projects the photograph on to a ground-glass screen of the same size as the photograph. Focussing is by eye: and by stopping down depth of focus and out of focus effects are seen at once.

Miniature cameras were designed to photograph on standard cine-film and make a photograph 24×36 mm. The first in the field was the Leica, made by Leitz. The full range of accessories and interchangeable lenses makes it a very good instrument for scientific work; lenses are now available from 28 mm. (short focus) to 200 mm. (telephoto) focal length. The Zeiss Contax is in some ways similar.

It is heavier, but has a metal focal plane shutter. The range-finder has a longer base; but some find the setting of the shutter speeds a trifle inconvenient.

In this class cheaper cameras are made, where interchangeable lenses are not available, the definition is not so precise, and the shutter speeds are restricted. The *Retina* by Kodak, *Super Nettel* by Zeiss, and one or two others are examples.

Some might make a case for the non-miniature camera, though the number who would recommend it, even under tropical conditions, is continually decreasing. For recording architectural and archaeological detail there are certain advantages in an ordinary stand camera where speed of manipulation is not called for, though even this class of work can be effectively done by the Leica, *e.g.* Tucci's excellent photographs of Tibetan *realia* and mural paintings.

But quarter-plate is not the smallest effective size. All recording work on the Barrier Reef Expeditions was done with $3\frac{1}{2} \times 2\frac{1}{2}$ inch, giving excellent illustrations for publication. In fact, rough plotting for survey has been done from these negatives.

The reflex camera with elaborate mechanism and difficult focussing is going out of favour because the point of view (from the chest) is likely to be blocked and is less easily shifted to take advantage of the moment.

Indisputable advantages of the miniature camera are (1) Quantity of film carried and exposures available on any occasion greatly increased: avoids running out of film or having to change plates during a series illustrating a complete movement. Rapid lens very important for anthropological work, where action must not be stopped; (2) Interchangeable lenses make it unnecessary to carry several cameras; (3) elimination of accessories like plate holders, ground-glass screens, focussing cloths, all a burden to carry, easily damaged, and give trouble in hot weather. Short focus lenses have great depth of focus, so that rapid shutter speeds are possible with large apertures. Their wide angle satisfactory for scenes of native life and much landscape work. They give sharp definition over the whole field, not increased by stopping down beyond about 6·3. Telephoto lenses are often used for portraiture with the miniature camera. The lens hood is more important than filters where light is bright.

We may therefore sum up the relative advantages thus:

Stand Cameras on tripods are used where time is of no particular consequence, as in studies of architecture, archaeology, etc. They take dark slides for plates, and cut film or film pack adapter up to half plate. Plates and cut film require dark-room loading, or loading bags; film pack can be loaded in daylight. Lenses are usually on separate panels or built-out box, and are interchangeable only when the dark slide is shut or the camera unloaded. Cameras have usually rising fronts, reversible backs to take picture horizontal or vertical, and swing motion to back and front to get plate vertical and lens axis perpendicular to it when camera is tilted up or down.

Hand Cameras which can be held in the hand or may be fixed to a tripod, rather quicker in manipulation, are adaptable for roll film, film pack, and plates, sometimes for all three: generally give smaller negatives than stand cameras. Lenses usually not interchangeable. They may be divided into four classes:

(*a*) With focussing on ground-glass screen interchangeable with plate holder or film pack adapter, but fitted also with a focussing scale to use with roll film or when there is no time for direct focussing. Some of the larger models have rising and swing fronts and reversible backs.

(*b*) For roll film only, generally small, focussing by scale or with built-in range-finder coupled to lens (automatic focussing), sometimes focal plane shutters and interchangeable lenses. Automatic focussing gives speed in operation, and precision.

(*c*) *Reflex* generally of larger sizes focussing on a screen in top of camera by a mirror at 45°, which is raised out of the way when the shutter is released. Take plates, or film pack, or sometimes roll film. Largely used for Press work, which requires separate glass plates.

(*d*) *Twin Lens Reflex*, one lens taking the picture, the second projecting the field upon a focussing screen in the top of the camera so that the image remains in view while the exposure is made. Coupled focussing so that when object is focussed on the screen it is also focussed on the film. Mostly small roll film cameras, lenses generally not interchangeable, with supplementary attachments for near objects.

In twin lens reflex cameras the focussing screen serves as a full-size view-finder, with image not inverted as in the direct-focussing screen.

(*e*) Miniature cameras not sharply distinguished from some of the preceding class but generally using kinematograph film 35 mm. wide. Give largest available number of exposures on one loading (36), and quickest in manipulation. Coupled lenses, that is lenses mounted so that image remains in focus when lens is interchanged; interchangeable while camera loaded. Automatic feed, daylight loading, device to make a double exposure impossible. Short focus lenses giving great depth of focus and large field of view: generally built-in range-finder and automatic focussing.

"The main items in our equipment were:

1 Kodak ¼ Plate Recomar camera, Compur shutter, f/4·5, and 40 Super-sensitive panchromatic and verichrome film packs.

1 Kodak 3¼″×2¼″ folding camera, Compur shutter, Goerz lens f/4·5.

1 Kodak 3¼″×2¼″ No. 1 folding camera, f/6·3, and 80 Super-sensitive panchromatic roll films.

I arrived in Greenland early in October, my headquarters being about lat. 70° N. Although there was snow on the ground and the weather happened to be good, the reflected light was extremely deceptive; in such circumstances, for instance, it was a mistake to use a smaller aperture than f/8 for a 1/25 sec. exposure, with a K1½ filter and panchromatic films. Instantaneous photography is not recommended from the middle of November until the end of January: certainly not with cameras whose lenses are similar to the above.

The winter photography was mainly experimental, so adequate supplies of developing and printing equipment were taken for such a purpose. Everything came from Messrs. Kodak, except the Agfa flash-powder; of this one had to use more than double the specified amount, as the walls and surroundings of a Greenlander's house are dark and lacking in contrast.

All the cameras were taken at the start of the summer sledge journey, but, in order to save weight, the ¼ plate and film packs were sent back from the edge of the Ice-cap. The chief disadvantage this entailed was that after this there was no focussing-screen camera for close-up photography; however, as was discovered on returning home, the strong summer light had often penetrated into the sixty or so negatives exposed during the 130-mile journey from Jakobshavn. This had only occasionally been experienced with film packs under winter or spring conditions; roll films, on the other hand, gave no trouble of this sort throughout the whole year.

The best Kodak was always used with a K1½ filter inserted inside the front Goerz lens. The inexpensive one, although originally taken as a stand-by camera, which of course took the same sized roll films, was used for the most part with a G filter; it has produced some surprisingly good cloud effects. Furthermore the G filter, as well as making the sky dark and the white clouds stand out, cut out haze and made the survey panoramas much clearer. Exterior attachable filters might have given better and more varied results, but they easily get lost or dirty and complicate proceedings for fingers already sufficiently cold.

A few photographs of blizzards were obtained by carefully shielding the

camera with windproof material. In perfect cloudless weather and about noon-time during the month of June, the shortest successful exposure for a distant panorama, with a f/32 aperture and a K1$\frac{1}{2}$ filter, was found to be $\frac{1}{10}$ of a second. A Justophol exposure-meter was often used for photographs of a more experimental nature; it was however necessary to allow for particularly cold weather making the film emulsion work more slowly.

From the experience gained on this expedition I would always, when weight must be considered, recommend small folding cameras for Arctic photography. They should preferably be of the reflex type, to be used with supersensitive panchromatic roll films and a selection of appropriate filters. With such equipment and a thorough knowledge beforehand of the cameras, most amateurs could obtain reasonably good results without undue difficulty."

Croft. Greenland. 86.249.

"Telephoto lenses are essential. They enable the complementary picture of a middle distant or distant picture to be taken, a function of all good cinematography, and the camera therefore should be fitted with a turret head so that the telephoto lens can be brought into use without delay or the necessity to fiddle with cold fingers.

The importance of a good stand cannot be over-emphasized. At high altitudes where breathing is more rapid, or after muscular fatigue when the body is unsteady, it is impossible to take steady pictures without a stand, or some form of support." *Smythe. M.E.E.* 1936. 89.507.

PHOTOGRAPHY FOR SURVEY. *By Michael Spender*

Emulsion

It is customary to use a fine grain emulsion in order to get very exact definition. An emulsion of sufficiently close grain was formerly very slow and of the process plate type. Modern miniature cameras have however caused manufacturers to produce fine grain films, nowadays considered slow, but as fast as the "snapshot" film of a few years ago; these films must sometimes be specially ordered. Slow speed is accompanied by other advantages: the emulsion is chemically more stable, is not so much affected by climate, and retains its speed; the exposure latitude is also greater. All these properties work towards attaining consistent and satisfactory results.

The slower, process-type, emulsions are conveniently used in plate cameras worked on stands. Ilfords now make a so-called Topographic emulsion for survey cameras. This is a modern form of the older Imperial process emulsion used with success by Major Mason in the Shaksgam in 1926. It could with advantage be retarded in speed somewhat, since in high mountains when the sun is shining the exposure at f/11 with a yellow filter is about $\frac{1}{5}$ sec. The Perutz

topo-emulsion requires about $\frac{1}{2}$ sec. under similar conditions, which can be given with a lens cap.

For air-survey work the greatest speed consistent with fine grain is required. Manufacturers are continually producing new films for air work. Whereas for most ground survey it would not be necessary to use panchromatic material, it would always be advantageous in air photography, partly because the sensitivity to red light improves definition where haze is present, and partly to get better tone contrasts. Ilford's Panchromatic air-survey film has been well spoken of and Agfa Aeropan gave first-class results in Greenland in 1933.

Plate or film

It was formerly thought desirable to use plates for all survey. For some curious reason it is easier to get good negatives on glass than on film: film shrinks after processing and may indeed contract irregularly; it is also difficult mechanically to ensure that the film is exactly in the calibrated focal plane of the camera. But the exigencies of air-photography have produced a film which contracts equally in all directions, and of cameras with devices such as glass pressure-plates against which the film is pressed during exposure. The advantages in weight and convenience are obvious. One of the few disadvantages is the occurrence of electrical discharges in certain atmospheric conditions, due to the friction between the two dielectrics, film and glass.

But now that air-survey technique has caused the intrinsic advantages of plates to be reduced, there seems no reason why film should not be generally used for ground-survey. The Zeiss firm have developed a film-cassette for their 9×12 cm. survey camera. At present this uses spools of 12 exposures of 5×4 inch film. There is something to be said for building a survey camera to take greater length of film, *e.g.* for 50 exposures. It is however necessary to use the thick air-survey-film base: an intractable material which causes problems of storage which do not arise with plates.

Exposure

The latitude of films suitable for survey is so great that exposure error must be very large to make the photograph useless. But occasions arise when some guide to exposure is necessary. One type of exposure meter, not used very much now, depends on the time taken for a piece of sensitized printing out paper to darken to a standard

tint. An other is a kind of eyepiece through which the landscape is inspected; the light is then reduced by a stop until nothing can be seen and the exposure reckoned from the size of the aperture at the threshold of vision. But neither of these can be recommended for expeditions, when judgement of colours and light values may become abnormal.

The two types of exposure meter worth considering are the calculator and the electric-meter. With the calculator certain factors such as latitude, date, time of day, altitude, state of the sky are combined to produce a light value, which is then brought into combination with a speed-factor for the plate or film being used, to give the exposure at various apertures. The Burroughs-Wellcome calculator contained in the annual diary issued by the firm is a well-known example. Another one well known on the continent is the Alpina exposure calculator.

The electric-meter reacts to the actual illumination of the scene to be photographed. The light falls on to an oxidized film on a metallic plate and there generates a potential difference between the surface and the plate; a sensitive galvanometer records the current. A rotating dial like that of the calculator relates light-value to speed-factor to give exposure. The instrument is very quick in use and requires the minimum of intelligence—an important consideration under expedition conditions.

Obviously the usefulness of the meter—assuming it to be in itself efficient—will depend amongst other things on the relation between the proportion of the spectrum which affects the film and the proportion which affects the meter. The Weston meter, for instance, has a maximum sensitivity in the yellow (at about 5800 Ångstrom units) and hardly reacts to ultra-violet light. In practice this is fairly immaterial for all familiar conditions. A make of film can be calibrated to the meter and excellent results are almost certain. This particular meter showed itself on the Mount Everest Reconnaissance able to endure harsh treatment; but there is a loop-hole for anomalous results and there is much to be said for the calculator. Such question can be settled only by the user.

Development

Development as soon as possible after exposure, that is to say in the field, has always been and will probably always remain desirable;

but it must be offset against the risk to material during development, washing, or drying; and the delay or fatigue it may cause the party. Modern material suitable for survey can endure temperature changes and delays before development without serious loss of brightness of the image. Certain things should however be borne in mind. Photographic material loses sensitivity continuously from the moment of production, but more rapidly after exposure than before. So exposures should be deliberately liberal if material is to be put away for some time before development. Another point, on which Messrs. Kodak have advised us, is that material should not be sealed up in tins after exposure. Where film is packed in tins, it is in a specially dry atmosphere, so that cooling cannot induce condensation. If however film is sealed up in a damp atmosphere and then cooled condensation will occur. In a litre of air at 90° F. at sea-level and 98 per cent. saturated there are ·03 gm. of water. It is better then to wrap up the material in newspaper and pack in tins in which holes have been pierced.

"In the Wild camera the so-called Topographic emulsion made by the Ilford firm was used on plate-glass plates. The material was developed in England after the plates had passed twice through the tropics. On development the plates were found to be in no way fogged; the images were bright and excellent. There were however disfiguring marks all over the plates in the form of patches of deposited silver. These deposits occurred where the surface of the emulsion had been rubbed against the surface of the plate packed opposite, during the long, jogging ride on yak or mule-back. The marks were visible before the development of the plates. Had the plates been repacked with separating strips of cardboard (as they are packed by the makers) no doubt this annoying trouble would not have occurred. I have never heard of a similar case of this source of damage. However it is not expected that the plates will be any less valuable for survey purposes from this cause.

The film material was the same as that taken to Greenland in 1933. It was the well-known Perutz 'Topo' emulsion on thick air survey film. On development (again after return) we were spared the disappointment of finding disfiguring marks. In fact most of the illustrations for this paper are from this survey camera. But there was a certain loss of brightness of the images, as though there had been consistent slight under-exposure. Something of the same sort happened to the film kept for a long time after the Greenland season, especially where the film had been kept in considerable warmth. After talking to Messrs. Kodak about these phenomena I realize that exposure should be deliberately made very liberal if there is a likelihood of delay before development.

The electric exposure meter by Weston was invaluable for all classes of photography and showed itself capable of standing up well to the severe conditions of a Mount Everest expedition." *M. Spender. M.E.E.* 1935. 88.299.

"At the first depot near the Veteran Mountains an interesting although unsuccessful experiment was made when the vicinity of the depot was reached in thick fog. A round of infra-red photographs was taken with the Leitz Leica camera and developed in the tent. The result showed that no great increase of visibility is obtained." *Glen. Spitsbergen* 84.111.

"Light values are not easy to estimate, and the tendency has always been to under-exposure during the march through the Sikkim valleys, where water vapour reduces values, and to over-exposure on Everest, where the value is very high. Exposure meters are of little value owing to the varying proportion of ultra-violet light as height is gained, but it should be possible to evolve a compensating table to aid the photographer who uses a photo-electric exposure meter." *Smythe. M.E.E.* 1936. 89.506.

DEPTH OF FOCUS

The focal length of an objective determines amongst other things its depth of focus, that is to say the range in distance over which focussing is approximately good. With a long-focus lens the depth of focus at full aperture is small. With a short-focus lens, even of greater angular aperture, it is much greater and thus the tendency in design of lenses has been towards short focal length and wide aperture, that is towards the lens for the miniature camera.

To obtain sharp views over considerable range of distance with a long-focus lens requires that it be stopped down and this increase of sharpness over the picture may give the impression that stopping down a lens increases its defining power, but this is wrong. If a lens could be perfectly corrected for its various aberrations, the greater the aperture the better would be the definition. There are of course elements of this law which cannot be realized altogether in practice, but in fact the greatest degree of definition is obtained with apertures between f/6·3 and f/9. Larger and smaller apertures give definition somewhat inferior. One must therefore choose the aperture to reconcile best the desirable depth of focus definition, and shortness of exposure. This can never be done with large cameras and long focus lenses. With modern short-focus lenses the depth of focus is remarkable, even with large apertures, and thoughtful use of the scales for depth of focus will show that for any given picture and conditions there is an aperture not too small beyond which it is disadvantageous to stop down. These scales for depth of focus fitted to modern cameras give great possibilities of placing the range of focus correctly.

APERTURE OF LENSES

The intensity of the image varies as the square of the diameter A of the stop and inversely as the square of the focal length F; that is, as A^2/F^2. For a given lens F is constant, and A can be varied by an iris diaphragm, whose settings can be regulated by a scale figured in F/A, not A/F. These numbers are commonly in geometrical progression with ratio the square root of 2, so that the intensity is halved and the exposure doubled for each step of the scale. There are two scales in common use, including parts of the series

	1·4	2	2·8	4	5·6	8	11	16
or else	1·5	2·2	3·2	4·5	6·3	9	12·5	18

Dallmeyer, Taylor Hobson, Zeiss, and others use the first, the R.P.S. scale, and Leitz the latter. Ross uses a mixture of the two, having sometimes both 4·5 and 5·6 figured. The table of page 236 shows that both are derived from the series $2^{n/6}$ by taking every third term but starting at a different place. The diaphragm is normally set at one of the scale figures, but may be set at intermediate points for finer gradation of intensity.

The smallest figure on the scale, giving the largest possible aperture, may not be a term of the series. Thus

Dallmeyer Super-six	1·9	2·8		4		5·6	8 etc.
Taylor-Hobson (Cooke IIA)			3·5	4		5·6	8 etc.
Zeiss Tessar 105 mm. ..			3·8	4		5·6	8 etc.

begin out of the series but are then regular; but

Ross Xpres 2·9	2·9	3·5	4·5	5·6	8 etc.

is irregular for several terms.

SHUTTER SPEEDS

Shutter speeds should be also in geometrical progression, but are usually not. The widely used Compur shutter gives exposures of 1 1/2 1/5 1/10 1/25 1/50 1/100 and then differently in different examples. Focal plane shutters are figured even more irregularly. Sector shutters cannot be set at intermediate speeds; some of the focal plane shutters can. But uncertainty of the correct exposure and the tolerance of modern films make refinement unnecessary. When in doubt give the longer exposure.

PLATES AND FILMS

Roll films, film packs, and cut films are easy to carry, but not convenient for development in the field. Glass plates are heavier

and bulkier than films but are easy to develop in the field and give better results; and if properly packed there is no danger of breakage.

Advise panchromatic plates or films, used with appropriate filters. Buy all plates backed; the backing needs no special attention and dissolves during development. Develop and handle panchromatic plates and films in complete darkness; with tank development this is no disadvantage. Most makers will pack in airtight tins if requested; after development pack the plates again in them; but do not re-seal the tins, or you may include moisture. In cold conditions the ordinary packing is quite satisfactory. To prevent breakage pack negatives by complete box-fulls. The ordinary plate box holds one dozen, and should be used to hold the same number of negatives, neither more nor less; the risk of breakage is then very small indeed. Pack negatives film-surface to film-surface. *C. J. Morris.*

Glass plates are not more convenient for development in the field; have found in Queensland that they became impossible at temperatures in which film can still be employed. Arguments in favour of films in memorandum on survey photography (p. 228) apply also to general work. Use of plates now restricted to press men who are compelled to print from wet negatives.

Orthochromatic films, with their more contrasty emulsions, are best for landscape. *M. Spender.*

SIZES OF FILM

The British and foreign roll films for the smaller cameras are generally interchangeable, and the cartons of foreign films for the British market are marked in British and metric measures only roughly equivalent. The smaller dimension, printed first, is near the width of the film, and this width is indicated by figures on British films and by letters and figures on German. Thus we have

Figure	*Letter*	*British size*	*[Metric equiv.]*	*Metric size*
27	A	$1\frac{5}{8} \times 2\frac{1}{2}$ in.	[4·13 × 6·35 cm.]	4·5 × 6 cm.
20	B	$2\frac{1}{4} \times 3\frac{1}{4}$	[5·72 × 8·26]	6 × 9
16	D	$2\frac{1}{2} \times 4\frac{1}{4}$	[6·35 × 10·80]	6·5 × 11
18	E	$3\frac{1}{4} \times 4\frac{1}{4}$	[8·26 × 10·80]	8 × 10·5

The sizes in British units correspond more nearly with the actual dimensions of the pictures: the frames measure 3 or 4 millimetres less than the metric sizes marked on the cartons. On the other hand, the actual film is wider; the four sizes of Kodak film measure 4·60, 6·19, 7·06, and 8·73 cm. before development; Selo and Agfa films have been

found to measure 4·59, 6·09, and 6·98 afterwards. Selo cartons are marked with the indicator figures 27, 20, etc. Kodak prefix the figures 1 or 6, giving 120, 616, etc. The prefix 6 for Kodak, Z for Selo, P. for Agfa, and the suffix M for Zeiss Ikon indicate films on small metal spools required for certain cameras, *e.g.* Kodak Six-20. Agfa use both letters and figures, B 20, D 16, etc.

Such, briefly, are the results of some enquiry and experiment: the subject does not seem to have been properly explored.

NAMES OF EMULSIONS

The same plate or film manufactured for different markets will often have different names; and films sold under one name in different countries will have different emulsions: hence much confusion. Compare the lists of emulsion speeds issued for use with Weston and other exposure meters in Great Britain and in the United States: few names are common to the two lists: see for example the Ilford (Selo) names in the two lists for Summer 1937: if occasional names are the same the speeds are different.

SPEED OF EMULSIONS

Exposure (within limits) varies inversely as the speed of the plate and the speed may be represented by a number proportional to the speed, as in the Hurter and Driffield system (H and D), or by a series of integers such as the Scheiner or DIN scales, where the speed corresponding to each number is 1·260 that of the preceding: and since $1{\cdot}260^3$ equals 2, a rise of three steps on this scale means double the speed.

The H. and D. numbers are determined from the relation between incident light and resulting density in the middle range of the plate, neglecting the "threshold" conditions when blackening first begins. They are measured with a standard candle, very unlike daylight.

Scheiner numbers depend theoretically on the exposure (to a standard amyl-acetate lamp, quality much like a candle) which produces just recognizable darkening: hence a threshold value. But in practice represent effective speed determined by estimate and empirical methods.

DIN (Deutsches Industrie-Normal) numbers are determined by exposing a plate under a graduated scale of densities to light of a tungsten lamp with filter to imitate daylight, pressing development to bring up the highest step of the photometric "wedge" which has density 0·1 greater than the fog on the plate: hence presumably the denominator 10 properly written with DIN numbers, *e.g.* 19/10.

Scheiner and DIN numbers run more or less parallel, with difference estimated at anything from 7 to 11.

Effective speed varies with type of work, and plates having same speed number for normal subject and exposure might show great differences for minimum exposure. One wants a number for the normal range and another for last developable detail in shadow; and different numbers for daylight and artificial light.

The Eastman Kodak films have no speed numbers on the cartons; Ensign, Zeiss Ikon, and others give Scheiner numbers; Ilford (Selo), Agfa, and others give DIN numbers. H. and D. numbers as such are little used, but the Weston Emulsion Speed numbers are based upon them, being approximately the H. and D. numbers divided by 50. Weston gives also Weston-Scheiner numbers (in the English list) and a table (with a Caution) showing their Scheiner numbers 7 units greater than the DIN. A few comparisons make Weston-Scheiner and DIN numbers about 3 units less than those given by the makers; but the Caution mentions cases of greater divergence for emulsions of special qualities.

EXPOSURE METER

The exposure required depends upon the intensity of the light, the aperture/focal length ratio of the lens, and the speed of the emulsion. The light is best determined by an exposure meter with thermo-couple or selenium cell, and fitted with adjustable dials to set against emulsion speed, measured light, and aperture to find the corresponding exposure. There are many patterns, among which, as comprehensive, we may take the Weston Universal Meter, Model 650. A table of emulsion speeds is provided: take care if buying material in England to get the English table and not the American.

Set the meter to the emulsion speed. Direct the opening to the object, standing, if the object is near, at a distance from it equal to the diameter of the most important part, and read the light intensity on the meter scale by the moving pointer. Set the arrow to the corresponding reading on the light dial, and select from their adjacent dials the aperture corresponding to the desired exposure or vice-versa. Study the 'Guide to Perfect Exposure' supplied with the meter.

All the scales of the Weston Universal Meter and of the preceding sections on aperture, exposure, and emulsion speed, may be related conveniently to a table of $2^{n/6}$, where n is integral, and runs from -40 to $+60$.

LIGHT, EXPOSURE, APERTURE, and SPEED NUMBERS related to a series in geometrical progression.

n	$2^{n/6}$	L	E	$1/E$	F/A			S			
			secs.		*R.P.S.*		*W.*	*H.D.*	*W.*	*Sch.*	*DIN*
−12	·250	1/4	4	·25							
−10	·315	1/3	3	·33							
− 8	·397	2/5	2½	·40							
− 6	·500	1/2	2	·50				50	1		
− 4	·630	2/3	1½	·66				63	1·2		
− 2	·794	4/5	1¼	·80				79	1·5		
0	1·000	1	1	1·00	1			100	2		
+ 1	1·122										
+ 2	1·260	1·3	4/5	1·25				126	2·5		
+ 3	1·414				1·4						
+ 4	1·587	1·6	2/3	1·5		1·5	1·5	159	3	14	7
+ 5	1·782						1·8				
+ 6	2·000	2	1/2	2	2		2	200	4	15	8
+ 7	2·245					2·2	2·2				
+ 8	2·520	2·5	2/5	2·5			2·5	252	5	16	9
+ 9	2·828				2·8		2·8				
+10	3·175	3·2	1/3	3		3·2	3·2	318	6	17	10
+11	3·564						3·5				
+12	4·000	4	1/4	4	4		4	400	8	18	11
+13	4·490					4·5	4·5				
+14	5·040	5	1/5	5			5	504	10	19	12
+15	5·657				5·6		5·6				
+16	6·349	6·5	1/6	6		6·3	6·3	635	12	20	13
+17	7·127						7				
+18	8·000	8	1/8	8	8		8	800	16	21	14
+19	8·980					9	9				
+20	10·08	10	1/10	10			10	1000	20	22	15
+21	11·31				11		11				
+22	12·70	13	1/12	12		12·5	12·7	1270	24	23	16
+23	14·25						14				
+24	16·00	16	1/15	15	16		16	1600	32	24	17
+25	17·96					18	18				
+26	20·16	20	1/20	20			20	2020	40	25	18
+27	22·63				22		22				
+28	25·40	25	1/25	25		25	25	2540	50	26	19
+29	28·51						29				
+30	32·00	32	1/30	30	32		32	3200	64	27	20

Extension at top of Table

n	$2^{n/6}$	L	E	$1/E$
−40	·0098		100s.	0·0100
−38	·0124		80	·0125
−36	·0156		64	·0156
−34	·0197		50	·0200
−32	·0248		40	·0250
−30	·0312		32	·0312
−28	·0394		25	·0400
−26	·0496		20	·0500
−24	·0625		16	·0625
−22	·0787		13	·0769
−20	·0992		10	·1000
−18	·1250		8	·125
−16	·158		6	·167
−14	·198		5	·200

Extension at foot of Table

n	$2^{n/6}$	L	E	$1/E$
+32	40·3	40	1/40	40
+34	50·8	50	1/50	50
+36	64·0	65	1/60	60
+38	80·6	80	1/80	80
+40	101	100	1/100	100
+42	128	130	1/130	130
+44	161	160	1/150	150
+46	203	200	1/200	200
+48	256	250	1/250	250
+50	322	320	1/300	300
+52	406	400	1/400	400
+54	512	500	1/500	500
+56	645	650	1/600	600
+58	813	800	1/800	800
+60	1024	1000	1/1000	1000

Column 1 gives the integer n.
Col. 2 the value of $2^{n/6}$ to 3 or 4 significant figures.
Col. 3 the values of the light intensity L as figured on the scale against which the pointer moves in the Weston meter.
Col. 4 the figures E on the exposure dial, and Col. 5 the inverse $1/E$.
Cols. 6, 7, 8 give the focal length by aperture ratios on the R.P.S. and Leica scales and the Weston dial.
Col. 9 gives the H. and D. speeds from which the Weston emulsion speeds in Col. 10 are found by dividing by 50. Cols. 11 and 12 give the Weston Scheiner and DIN speed numbers which correspond approximately.

Observe that the figures for L, $1/E$, F/A, and H.D. are all closely related to the value of $2^{n/6}$ in the same line, and that the Weston emulsion speed S is proportional to H. and D. This allows us to calculate easily products of these quantities or their powers. For example:

Exposure E varies inversely as Intensity of image and emulsion speed S.

And intensity of image varies directly as the light L and inversely as the square of F/A.

Hence $1/E = L \times A^2/F^2 \times S \times$ a constant.

This is troublesome to calculate with the actual values of L, F/A, and S. But since all these quantities are approximately terms in the series $2^{n/6}$ we may work by the rule of indices and write

n for $1/E = n$ for $L - 2n$ for $F/A + n$ for $S +$ a constant.

Example

n for L	160	$+44$
$-2n$ for F/A	8	-36
n for S	32	$+24$
constant		$+\ 8$
Sum		$+40$ is n for $1/E$ E is $1/100$ *sec.*

Or if we want to find the aperture for given exposure, light, and emulsion speed we have

$2n$ for $F/A = n$ for $L - n$ for $1/E + n$ for $S +$ constant.

Example

n for L	65	$+36$
$-n$ for E	$1/80$	-38
n for S	8	$+12$
constant		$+\ 8$
Sum		$+18$ is $2n$ for F/A ; n is 9 ; F/A 2·8

The constant is determined by trial.

DEVELOPMENT IN THE FIELD. *By C. J. Morris*

Tank development has replaced development in open dishes. The exposed plates are immersed in a light-tight tank for a time which varies with the strength and temperature of the developer. With correctly exposed plates tank development will give technically perfect negatives; and with over or under exposures the results will be far better than can be obtained by any other method. With modern dry plates great errors in exposure may be made and perfect negatives still produced; but if there is any doubt about the exposure, the best results will be obtained with a weak developer and longer development. Carry developer in tablet form. Particulars of strength of solution, time, and temperature of development, are included with each package.

A dark room tent is heavy and difficult to transport. After dark, plate holders and developing tanks can be filled in one's tent, or even out of doors on a dark night; but it is more convenient to use a light portable dark room of three-ply wood with curtains of double black sateen supported on folded metal stays, placed on a box or table at which the operator sits. He puts the upper part of his body inside

and tucks the curtains in all round him. Illumination is by a small glass window; red for ordinary plates and green for panchromatic.

If a portable dark room is too cumbersome, take a changing bag: a large light-proof bag with openings at each side through which the arms, plate-holders, and tanks are inserted. The operator cannot see what he is doing and must rely on touch. Most commercial changing bags are too small; but a suitable bag can be made from three thicknesses of any strong thin black material.

Tanks should hold one dozen plates, and two or three are required to deal with large batches of negatives. There are many varieties on the market; in selecting one try and visualize the ease with which it may be filled when working in the dark with cold fingers. In cheaper tanks the plates are held by bands of corrugated metal, which look easy to fill; but in the dark it is often difficult to place the plates in the correct corrugations. In the best type of tank, such as the Dallon, the plates are held by loose metal strips placed in position after each pair of plates has been put into the holder. It is easy to fill this type of tank in complete darkness, and almost impossible to make a mistake. Moreover, the tank is so constructed that the plates can be fixed and washed in it without removal.

In great cold there is little fear of exposed plates deteriorating, and it is possible to postpone development. Commence operations as soon after sunrise as possible so that the developed negatives may be put to dry at the warmest part of the day. If negatives are not dry by sunset it is essential to put a lamp near them to prevent freezing. Very cold solutions are uncomfortable to use and work slowly. Slightly heat all solutions before commencing operations; but in working out the time of development allow for the developer cooling rapidly.

When development is complete empty the liquid out of the tank and fill with clean water. Allow this to remain for about two minutes, turning the tank over and over several times in the meantime. Empty the water out and fill the tank with the fixing solution, normally of acid hypo at the maker's recommended strength. After the plates have been in the hypo solution for some minutes open the tank and examine the negative in daylight. As soon as fixing is complete empty the hypo solution out, remove the plate-rack, and without removing the negatives give a preliminary wash in clean water. At the same time wash out the tank well to clear it of all traces of

hypo. Return the plate-rack to the tank which, by removing both stoppers to allow a free flow of water, may be used for washing the negatives.

The camp will usually be near running water, and even if it be partially frozen over there will nearly always be water underneath the ice. Wrap the tank in several thicknesses of butter muslin and put to wash in the running water. If there is risk of the tank being washed downstream weight with a large stone. If the water is frozen over, knock a hole in the ice, lower the tank, and keep in place by such means as occur to the ingenuity at the time. Even if the water is discoloured, or has much foreign matter in suspension, no damage will ensue to the plates; the butter muslin wrapping will keep out large particles, and if, as frequently happens, a slight scum forms on the film-surface of the negative, it does no harm and is easily removed later with a swab of cotton-wool, or by licking the wet negatives. After the negatives have been washed for about half an hour, remove the tank from the water, take each negative from the rack separately, wash the film-surface with a swab of cotton-wool soaked in clean water, and place to dry. As soon as dry, number and repack negatives in their original boxes; then seal up with adhesive tape. See that the numbers agree with those already entered in the diary.

Always remove exposed plates from the plate-holders as soon as possible and pack in their original paper wrappings and boxes, film-surface to film-surface, pending development.

It is difficult to keep plates and films fresh, even when not exposed, in great heat, and particularly with great humidity. In these conditions it is best always to develop negatives as soon after exposure as possible. Before development, if the films or plates cannot be kept cool, it is important that at least they be kept at a uniform temperature, and particularly that the boxes containing them be not exposed to the direct heat of the sun. If the packages get hot the sensitized film deteriorates rapidly.

If in hot weather it is not possible to cool the water, mix the developer stronger than usual, to complete development more quickly, and lessen the risk of the film softening. Develop at night, when the temperature is lowest. If the normal temperature of the water is above 80° F., draw the necessary water towards the evening and set it out to cool. Start work about 3 a.m. so that when daylight

comes the plates will be ready to dry in the quiet and cool conditions of early morning. Later in the day troubles may arise from insects and dust; always cover the drying negatives with butter muslin.

A freshly prepared hypo bath is considerably cooled in dissolving the salts. Film taken from a cold fixing bath to wash in warmer water may break loose from its supporting base. In tropical conditions always use an acid fixing bath, and slightly increase the normal proportion of acid to hypo. Add some form of hardener to the fixing solution. If films after fixing show any sign of reticulation increase the proportion of hardener.

The secret of producing successful negatives when the water is between 80° F. and 85° F. is to develop reasonably quickly, *e.g.* in four minutes, to fix in an acid fixing bath with sufficient hardener, and to keep all solution at roughly the same temperature.

"Over six hundred good negatives were obtained, including pictures of animals, orchids, rivers, mountains, and cloud views, floral zones, native parties, and a complete record of all natives who worked for us. Synge, the official photographer, used a Soho Reflex $\frac{1}{4}$-plate tropical camera with Dallmeyer Pentac f/2·9 lens and a Ross Teleros f/5·5, 13″ lens; and a $2\frac{1}{2}'' \times 3\frac{1}{4}''$ Etui camera with Zeiss Tessar f/4·5 lens. Ilford Special Rapid backed Panchromatic plates were satisfactory (film packs tended to jam). Hobby and Moore used a Voigtländer f/4·5 and a Nagel f/6·3, ordinary $2\frac{1}{4}'' \times 3\frac{1}{4}''$ models, with anastigmatic lens; ordinary Kodak No. 120 roll films were found better than Verichrome in which the backing stuck to the negatives. Dallon and Kodak tanks and Tabloid tancol were used for developing, which was done on the spot; sodium sulphate, 10 per cent. by weight in the developer, followed by a bath of chrome alum for ten minutes, were used as hardeners. Drying was very difficult, and many negatives were injured by dust and foreign matter in the air; it was found best to hang films (securely fixed against wind) for twenty-four hours in the roof rafters of our camp. Kodak negative albums were used for storing, and plate negatives were sent back to Singapore as often as possible. In the open f/16 was found best; mountain views on clear days required $\frac{1}{2}$ second at f/11 (with heavy filter), on misty days 1–2 seconds at f/16; in the rain-forest 6–10 seconds at f/22."

Synge, Hobby, and Moore. Sarawak. 82.402.

"The dust falls like dew in Turkistan, and it is hard to develop without the negatives being spoiled by dust. Water is often bad, commonly brackish, with sulphur, in the plains. Pure water rare except in mountains. Plates last longer than films, and are less sensitive to temperature, but heavy, and like many good things, are out of fashion. Carry two, if not three, cameras of the same size of plate or film. Always use a filter for exposures. The tables given in Burroughs and Wellcome's photographic almanac are excellent."

Schomberg.

"Any one working in this damp forest must be prepared for serious photographic disappointment. To begin with, the light in the forest is tantalizing. Every window in the overhead canopy lets in a narrow stream of sunlight which ruins an exposure for a dark object on the forest floor. In Europe we expose when the sun comes out; in the forest we must wait, sometimes for hours, until it gets behind a cloud. Each subsequent stage has its particular snag. Films stick to the aprons in the developing tanks; they blister or melt in the fixative solution; they refuse to dry in the humid atmosphere; and even when carefully packed away they make a splendid medium for the growth of moulds. Prolonged exposures, development in the early hours of morning, the use of freezing mixtures and hardeners, the employment of a hypo-killer, are the points we found worth special attention in dealing with these particular snags." *Hingston. British Guiana.* 76.9.

DEVELOPMENT IN THE TROPICS

There are two schools of thought, represented by the Kodak Technical Department which advises development as soon as possible after exposure and never to store exposed film, and on the other hand by the Leica, which advises to wait for good conditions before developing and store exposed film in moisture absorbent packing. Kodak's advise films specially packed for use in the tropics. Never restore films unpacked to a closed container; if they are put into a metal box for protection it should be perforated to ensure free circulation of air. Always develop films as soon as possible after exposure in solutions maintained at an even temperature by devices for cooling. Use a non-staining developer such as Three Century developer, diluted with equal bulk of water to every 10 oz. of working solution, add 30 drops of 10 per cent. solution potassium bromide and $1\frac{3}{4}$ oz. of sodium sulphate at 90° F. This strong developer completes development in $2\frac{1}{2}$ minutes for roll and cut film, 3 to $3\frac{1}{2}$ minutes for film packs. Development in shortest possible time avoids undue softening and swelling of the gelatine.

For development in tropics seven minutes should be maximum; aim at three minutes. A Chrome alum fixing bath essential, or better, use a stopping and hardening bath between development and fixing. Canvas cooling bags give large quantities of water at 75°, when the wet bulb thermometer, as often, is as low with air temperature 100°. Fine mica in the water is often troublesome. Recommend the book 'The Fine Grain Negative,' by Augustus Wolfman (Fromo Publishing Co., Canton, Ohio, U.S.A.).

M. Spender.

COLOUR PHOTOGRAPHY

It is possible because one can find dyes which transmit more or less equal thirds of the spectrum, red, green, and blue violet regions, and stop out the other two thirds. If then we photograph a subject through these three screens, we record separately the red, green, and blue-violet components of the light which is reflected from or emitted by the subject, including of course the constituents in these three colours of white light. From the three negatives thus made the picture is reconstituted in colour by making positives which either add together the correct proportions of light in the three screen colours, or subtract from white light the correct proportions of the complementary colours. These processes are therefore called the additive and subtractive processes.

The above account is of course over-simplified. The three colour screens do not make such a clean-cut separation of the spectrum, or they could not produce for example a pure yellow, or apparently pure, which they do; there must be some overlapping. But long research into the absorption spectrum of modern dyes has succeeded in finding compromises which produce an effect surprisingly near the original.

THE ADDITIVE PROCESS

The screen is a fine mosaic of patches of the three screen colours so close together that they are indistinguishable to the eye, and the mosaic is in contact with the sensitive film between it and the lens. On exposure in the camera, each colour element transmits the light of its colour which falls upon it and rejects the rest. If one developed and fixed a negative at this stage each coloured element would be more or less blocked by its image in proportion to the intensity of the light which had passed through, and if we examined the negative by transmitted light we should see a picture in complementary colours; corresponding to a red object the red mosaic cells would be blocked and the green and blue would be clear.

But instead of fixing at this stage we bleach out the developed image on the negative and redevelope the unaltered silver bromide which remains to obtain a positive, in precisely the same way that the ordinary 16 mm. kinematograph film is processed to give a unique positive. When the negative has thus been changed into a positive, each colour element of the mosaic transmits a proper proportion of

its own colour, and when it and its adjacent elements are fused together by the eye, which cannot distinguish between them, the picture appears in its proper colour.

There are several processes of this kind on the market, and the following account is extracted from a paper by Dr. D. A. Spencer in the *Geographical Journal* (80,235, September 1932), with additions which Dr. Spencer has kindly made to bring it up to date.

The Lumière Autochrome is typical of Mosaic Screen processes. Three equal portions of potato-starch grains are dyed respectively red, green, and blue-violet. The dyed grains are mixed and dusted on to a glass plate covered with a tacky coating. The surplus grains are dusted off, and those adhering to the glass are flattened out under great pressure, producing a mosaic of microscopic colour filters. Upon this mosaic a panchromatic emulsion is coated, and the resulting plate exposed in the camera with the mosaic nearest to the lens.

After development there is under each colour element silver deposit whose opacity is proportional to the intensity of the light which has passed through (and to the light which must pass through again to reproduce the colour). This deposit is now dissolved out, leaving the unaltered silver bromide unaffected. The plate is then developed again, and fixed, after which each colour element will have a transparency equivalent to the first opacity, and allow appropriate portions of their respective colours to pass. These are blended on the screen or by the eye to reproduce the original colour. All mosaic screens are based upon the same general principles, differing from each other chiefly in the methods by which the mosaic is produced.

The Lumière Autochrome is available on either glass plates or as cut films. The exposure required is about sixty times as long as an ordinary plate (H. & D. 250), and snapshot exposures are therefore possible only in tropical countries or at midday in midsummer in England.

The Agfa mosaic is built of coloured gum particles instead of starch grains, and the plate requires less exposure than the Autochrome.

The Dufaycolor mosaic is geometrical, made by printing coloured lines at angles to one another on a cellulose acetate base. The resulting mosaic contains over one million colour elements to the square inch. All three systems are available as roll films and film packs. Since the emulsion is preferentially sensitive to blue light, one must generally use a compensating objective filter to reduce the blue. Agfacolor and Dufaycolor roll film do not require this filter in normal daylight; the compensation is obtained by using emulsions of new type and giving

the mosaic a predominating tint which makes it act as a filter. Dufaycolor is also available in 16 mm. kinematograph film.

When the mosaic and emulsion remain throughout on the same support there is a loss of saturation on copying unless special precautions are observed and this work is best left to the manufacturers. Dufay-Chromex, Ltd., of Elstree, have established processing stations for development and duplication.

In the Finlay process the ruled colour screen is separate from the negative, which is exposed through it. Any number of positives may be made from the negative and viewed in colour by careful superposition of a colour screen.

The Kodacolor process, confined to 16 mm. cinematography, required a special screen of three coloured strips over the objective, and negative film with minute corrugations on the clear celluloid base which acted as cylindrical lenses. The process was fully described with diagrams in a paper by F. B. Phillips (*Geographical Journal*, 80.240, September 1932). The projector was fitted with a similar colour screen. When projected with a powerful light on a small screen the result was often excellent, but the projectors were never developed for use in large halls, and the process has now been superseded by Kodachrome, though the film and the special filters are at present still stocked by Kodak, Ltd., and the processing service is at present still available for those who wish to continue using the method.

THE SUBTRACTIVE PROCESS

Photograph in quick succession or simultaneously through screens which pass the red, green, and blue only, and obtain three negatives in which the red, green, and blue components of the picture are represented by blackened silver. From these three negatives make three positives (by a technique which we need not specify for the moment) in transparent colours which we may call minus-red, minus-green, and minus-blue. They are in appearance blue-green, magenta-pink, and yellow, but it is confusing to think of them thus.

The minus-red positive allows red light to pass where it is wanted, either as red or as a constituent of other colours and of white, but stops it where there is no red wanted. Similarly for the minus-green and minus-blue positives. Hence if we superpose the three and pass white light through, we have a transparency in colour and in white where it is required. Note that where the picture should be white all three positives are clear, and the full white light can pass. Hence subtractive colour transparencies are brighter than additive.

The Kodachrome process, with great ingenuity, makes the three negatives on the same base, clears, and stains them so that the three minus-colour positives are superposed automatically (see later). It was available until recently (1937) only for 16 mm. film, but it has now been made in 35 mm. width for Leica cameras and can be applied in principle to larger material for still pictures.

To make colour prints on paper we must superpose transparent prints in the three minus-colours: a difficult technique, but realized in the commercial processes Carbro and Vivex.

Various cameras have been made to facilitate rapid exposure of three successive negatives through the three screens or to make the three negatives simultaneously by dividing the light from the lens inside the camera by an arrangement of prisms or mirrors (see Dr. Spencer's paper *loc. cit.*). Some of these one-shot cameras, while of value to the studio worker, are of little use in the field. The Taylor Hobson (Vivex system) one-shot camera has been specifically designed for snapshot work out of doors. Successful colour photographs have been made from aeroplanes with this camera but its weight (14 lb.) is a handicap when the photographer must carry his own equipment.

KODACHROME. *By D. A. Spencer*

A transparent film base is coated on one side with a black anti-halation backing and on the other with three separate emulsions separated by two clear layers of gelatine. The five layers so formed are scarcely thicker than the regular photographic emulsion. The three emulsion layers are sensitized to blue, green and red light respectively; and the top or blue-sensitive layer contains a filtering dye to prevent excess of blue light fogging the lower layers. The second layer thus receives the green and red light but as it is sensitive to green light but not to red, it registers only the green image and passes the red light to the bottom or red-sensitive layer. By an elaborate reversal processing system involving the differential bleaching of the various layers and the employment of so-called dye-coupling developers, the three layers are so treated that finally they bear positive images in colours which are complementary to their original sensitivities. Thus the top or blue sensitive layer bears a yellow positive image, the green sensitive layer bears a magenta image and the red sensitive layer a blue-green image. In the last steps all the silver present in the photographic emulsions is removed

so that finally the film consists only of three transparent dyed gelatine layers.

Any 16 mm. motion picture camera can be used without extra equipment. For photographs of distant landscapes, especially where there is a haze in the atmosphere, use a special anti-haze filter. The effective speed of the film is about half that of Cine-Kodak reversal panchromatic film, so that the lens diaphragm must be opened one stop further than if regular Cine-Kodak panchromatic film were being used. The film can be projected on any 16 mm. projector without the use of special lenses or filters and the colour rendering is noticeably enhanced because of the absence of structure due to lines, starch grains, or ruled pattern. The absence of silver from the final projected film results in an image even less granular than that obtained from normal photographic processes. In view of the comparatively high speed of the film, direct sunshine is not necessary in order to get results of good quality; avoid hard cross-lighting and rely on the colour contrast of the subject rather than on extreme luminosity contrasts formed by highlights and shadows.

As with all Cine-Kodak film products, the film is sold at a price which includes processing charges. Obtain the latest information on processing stations established. Kodachrome films should be sent to one of these centres as soon as possible after exposure, and they should not be exposed to tropical climatic conditions, especially between exposure and processing, any longer than necessary. Instructions on exposure, etc., are contained in the cartons and further particulars are available from the makers and from photographic dealers.

The best results seen in the last two years at the R.G.S. are certainly with Kodachrome. On his mission to Lhasa in 1937 Mr. B. G. Gould and his staff took much Kodachrome film. They were able to despatch consignments of the undeveloped film by postal messenger to India and thence to London by airmail. As it was developed, reports on its success were cabled to Lhasa with suggestions for any necessary modifications in exposure. Results were remarkable, especially in their record of the costumes worn in the monastery dances.

COLOUR PRINTS ON PAPER. *By D. A. Spencer*

There are two practical methods for making small numbers of paper prints from separation negatives.

The Carbro process involves making bromide prints from the separation negatives and using the silver in the surface of the prints

to harden, by appropriate chemical treatments, pigmented gelatine plasters brought into contact with them. These plasters are treated with warm water to dissolve away unhardened, unwanted gelatine, and the residual hardened images (pink, yellow, and blue) are assembled in register on a sheet of paper.

The process in the hands of a skilled worker is capable of giving excellent results. The Vivex process of Messrs. Colour Photographs (B. & F.), Ltd., is, in its broad essentials, similar to the Carbro process, but the operations have been modified and standardized and the conditions under which the prints are made have been brought under exact control. As a result, it is possible to obtain the best possible result from each separation set with a minimum of wastage and expense. Since standardization of the process involves the control of voltage, temperature, and humidity at each stage, the process can be worked only under factory conditions. The advantage from the photographer's point of view is that his task is confined solely to producing the separation negatives.

This Company also undertakes the making of separation negatives and paper prints from mosaic screen transparencies and where a record on paper is wanted, probably the most convenient and satisfactory course for the traveller is to use a film system such as Dufaycolor and have prints made from the successes by a firm specializing in this intricate business. The inevitable slight loss in quality which results from copying additive transparencies is offset by the portability of the equipment to be carried by the traveller and, where necessary, hand work on the print can be employed to restore this loss. When it is known that subtractive paper prints are eventually to be made from additive transparencies, the transparency should be processed so as to produce a somewhat denser original than would be regarded as the best for viewing as a transparency. This increased density is obtained by making the first development to a negative appreciably shorter than that required for a bright transparency with no deposit in the highlights. Dense originals resulting from under-exposure are however of no use for this, or any other purpose.

ADVANTAGES AND LIMITATIONS OF COLOUR-FILMS.

By G. B. Barbour

The colour values obtained depend on reactions of standardized emulsions to light from illuminated objects. As that illumination varies (*e.g.* in the late afternoon) our visual sense adjusts to our surroundings by a mental process of automatic compensation which the emulsion does not possess. Towards evening we are hardly

conscious of decrease in illumination from the violet end of the spectrum until the warmth of colouring is definitely noticeable. But the falling off of ultra-violet increases the red effects on the film and alters all the colour values before the eye detects the change.

Still more marked are the effects over sunlit snow or at high altitudes, where the increase of ultra-violet favours the violet end of the spectrum and exaggerates the mauve tones on the film. The use of a colourless celluloid filter partly compensates for this latter effect, but it remains true that colour-films taken under extreme conditions of lighting at either end of the spectrum call for some degree of mental accommodation on the part of the audience. This commonly alleged defect can be largely obviated by careful editing to avoid sequences which jump abruptly from normally-lit scenes to those taken under extremes of lighting; it is sometimes worth while disturbing the sequence of scenes as taken, to make transitions in lighting more gradual.

With good illumination there is little to choose between the various makes of film. Many scenes that give most disappointing results on black-and-white yield really exquisite effects with colour-film. This is especially true of scenes on dull days where the range of tints rather than bright colours give the scene its character. The writer has secured excellent results of such unfavourable subjects as New York harbour on a grey day, a misty dawn on the Yangtze, the North China Plain in haze, Hawaiian peaks in the rain, and sunset through fog at Battersea.

Over-exposure tends to "fade" the colours in all additive films more or less uniformly; with Kodachrome, in addition, the colour balance is upset. Under-exposure yields a dense film with detail observed as if taken at dusk.

The speed of colour film is distinctly slower than that of white-and-black. Since shutter-speed of cinecameras is constant (or at best can be altered only to half or quarter-speed), adjustment of exposure must be made by aperture. While cell photometers are of use, the inability to compensate for unequal distribution of light wave-length in the image makes them scarcely of more value than experience.

The supersensitive emulsions used in colour-films are definitely more liable to deterioration than the stabler black-and-white. Exclusion of moisture by tropical packing in hermetically sealed

tins removes the most serious factor. There remains the possibility that high temperature alone may cause deterioration leading to image-fading irrespective of the humidity factor. No precise information on this point is available as yet, but Kodachrome is obviously more liable to change of colour-balance from this effect than additive film. Until more experience is gained, the best course is to insist on tropical packing at the factory and cool storage wherever possible, while for protracted work in highly humid equatorial regions the only safe plan may be to rely on black-and-white.

Deterioration after exposure is engaging the attention of manufacturers. The effect of light on the sensitive film is so to alter the relative stability of the different areas of the emulsion that they react differently to the developer. Until development, no change is visible to the eye, the picture being still only a latent image. On its sharpness and contrasts a good picture depends, and delay in development risks deterioration of that latent image. This risk is present to varying degree in all films, but is naturally greatest in the ultra-sensitive emulsions needed for colour work. In additive films the single uniform emulsion is all equally liable to latent image deterioration and fading. In the case of Kodachrome, the three layers, being sensitive to different spectral ranges, differ sufficiently in this respect to cause change in actual colour balance. Experience in this matter is still too limited to allow generalization, but the solution of the difficulty seems to lie in devising a simple technique for carrying out the first development of the negative in the field. The latent image danger is thus removed, and the negative can be reversed and processed to completion at a later date. Research is in progress on this point and equipment for such field development may be expected shortly.

Plants for processing additive films exist in most countries. Their work is not all of equally good quality and the writer has for instance had valuable films spoiled by poor development in Shanghai. But the parent companies are alive to this problem and are doing their best to control the standard of work of their representatives in outlying places.

The processing of subtractive film (Kodachrome), involving the much more complex operations of triple staining, can as yet (1936) be done at a few centres only—London, Rochester (N.Y.), San Francisco; other processing plants are being erected.

Development yields three superposed negatives. Further processing combines reversal with staining, all three sensitive layers being first coloured green, by a dye which unites chemically with the constituents of the developed emulsion. Thereafter, immersion in a special decolorizing solution is carefully *timed* so that only the two upper positive layers are penetrated, and the film is removed and washed before the third layer has had time to be affected. A second staining bath inserts the second colour, but does not affect the lowest (green) layer, the chemical stability of which prevents further reaction with the second dye. Briefer immersion in a second decolorizing bath is carefully timed to attack only the topmost emulsion, so that two of the three layers are now permanently stained and rendered immune to the last dye. This is a yellow stain which completes the process by reacting with the uppermost sensitive layer only.

There seems no reason to fear that the images on colour-films are less permanent than those on black-and-white. Cases are reported where faulty processing or improper storage over long periods has led to a separation of partial stripping of one of the layers (filter or emulsion) from the celluloid base. But such rather rare failures seem to be no more frequent than with black-and-white, and with reasonable handling it should not occur if normal precautions are taken for storing in suitable humidified containers.

A serious disadvantage, shared at present by all types of colour-film, is the difficulty of duplication in colour. Black-and-white copies can readily be made, but the original remains the only coloured one. This is largely a matter of cost. The demand for multiple copies—so paramount in the cinema industry where very complicated and extremely expensive methods of reproduction are justified—does not extend to amateur work, and as yet there has been no call for the necessary research and costly technique it would involve. Black-and-white copies made from additive film share the defect of their originals in the matter of enlargement, the filter pattern being inherited by the reproduction; when over-enlarged, the grain of the filter (crosshatching or banding) has the objectionable appearance of a coarse-screened half-tone newspaper illustration.

In all additive methods the image is broken into minute elements of three colours, which limits the area of sensitive surface available for recording any one colour, and loses illumination. Also the small colour-elements, when projected beyond a certain magnification, become plainly visible. This sets to the useful enlargement possible a limit quite independent of the projector's candle-power.

The great advantage of additive films is that they are processed

precisely like black-and-white films and that under extreme tropical conditions they are believed to be somewhat more stable.

Subtractive film (Kodachrome) has both greater brilliance when projected in the same projector, and its magnification is limited only by the candle-power and definition of the projector, since the grain of the emulsion itself is negligible. The writer has shown 16 mm. Kodachrome at the R.G.S. when the width of the picture successfully thrown on the screen was 14 feet—a magnification of about 270×.

CLASSIFICATION OF CAMERAS

Cameras may be classified by the method of focussing:

I. Screen focussing: camera objective throws image on ground glass screen in place of the plate; bellows racked in and out until image appears sharp when viewed from behind through screen. Generally also divided scale on rack for rapid work. Stand or hand cameras.

II. Reflex focussing: screen fixed in top of camera, with movable mirror set at 45° to project image on screen. Focus by racking lens in and out; camera generally solid. Mirror moved away just as exposure made. Usually hand cameras.

III. Twin reflex coupled focussing: double solid camera, one objective projecting on plate; second by 45° reflector on screen in top. Lenses coupled so that focussing on screen focusses also on plate. Usually hand cameras.

IV. Range-finder coupled focussing: single bellows or solid camera with range-finder coupled to objective so that setting range-finder brings image into focus. Hand or stand cameras.

V. Scale-focussing: all bellows cameras, with divided scale on lens mount or baseboard, set to distance of object. Precision of focussing depends entirely on accurate calibration. Hand or stand cameras.

In the following summary list of cameras widely used, British and foreign, the first figures, a rough index to the class, are the 1937 prices to the nearest pound of the least and most expensive of the make: they depend principally on the quality of the lens, and some makes have a whole range of lenses between these limits. Next comes the Maker and the Name of the camera; then the picture size to a quarter of an inch or in cm. and mm.: "also halved" means that the film may be masked and turned to make twice as many pictures of half the size; then the base of the emulsion: plates are glass, pack is thick cut celluloid, film is thin roll film, 35 mm. film is kinematograph film pierced for sprockets. Then comes the maximum aperture and name of lens; the type of shutter, blade, sector, or focal plane; and the type of camera, bellows or solid: in the former the front, carrying the lens, is

racked or slid in and out; in the latter the front is solid with the back, and all extension is in the lens sleeve. "Also screen" means that there is an auxiliary glass screen for precise focussing.

I. Screen focussing and auxiliary scale. All bellows cameras

15 to 18. Guthe and Thorsch. Patent Etui $9 \times 6{\cdot}5$ and 12×9 plates and packs or 20 and 18 film adapter. F/4·5 Tessar. Sector. Also 6 to 8 Junior model. Radionar 1/4·5. Folds very thin.

18 to 19. Newman and Guardia Baby Sibyl. $4{\cdot}5 \times 6$ cm. Plates and packs. F/4·5 Wray or Ross Xpres. 2 blade shutter.

21 to 23. N. and G. New Special. $3\frac{1}{2} \times 2\frac{1}{2}$ plates and packs or $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film in adapter. F/4·6 Wray or Ross Xpres. 2 blade.

21 to 33. Ensign Sanderson. $4\frac{1}{4}$ by $3\frac{1}{4}$. Plates and packs. F/4·5 Dallmeyer to F/5·7 Ross Combinable. Sector.

22 to 50. Sinclair Una. $3\frac{1}{2} \times 2\frac{1}{2}$ to 7×5 in six models. F/6·8 Ross Homocentric to F/5·5 and F/11 Ross Combinable. Sector.

23 to 25. N. and G. New Ideal. $4\frac{1}{4} \times 3\frac{1}{4}$ plates and packs. F/4·5 Wray or Ross Xpres. 2 blade.

29 to 30. N. and G. Vitesse. $3\frac{1}{2} \times 2\frac{1}{2}$ plates and packs, or $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film. F/3·5 Ross Xpres or Dallmeyer Dalmac. Sector.

37 to 55. Adams Verto and Valdo in several sizes. $3\frac{1}{2} \times 2\frac{1}{2}$ to $5\frac{1}{2} \times 8\frac{1}{2}$. F/5·5 Ross Combinable. Plates and packs; also film. Sector.

54 to 77. Zeiss Ikon Nettel. 9×12 cm. plates and packs. F/4·5 Zeiss Tessar to F/2·8 Bio Tessar. Focal plane.

II. Reflex focussing: generally solid cameras with focal plane shutter

12 to 26. Thornton Pickard Junior Ruby. $3\frac{1}{2} \times 2\frac{1}{2}$ plates and packs; $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film in adapter. F/4·5 to F/2·5 Cooke.

13 to 30. The same, with $4\frac{1}{4} \times 3\frac{1}{4}$ and with 12×9 cms.

15 to 32. Ihagee Exacta. $4 \times 6{\cdot}5$ on 27 film. F/3·5 Exaktar to F/1·9 Dallmeyer. Also 20 to 48 Model B.

28 to 55. Ihagee Kine Exacta. 36×24 on 35 mm. film. F/3·5 Exactar to F/2 Zeiss Biotar.

31 to 38. Soho Reflex. $3\frac{1}{2} \times 2\frac{1}{2}$ plates and packs or $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film in adapter. F/4·5 Ross to F/2·9 Dallmeyer. Also 32 to 39. $4\frac{1}{4} \times 3\frac{1}{4}$.

47 to 57. Newman and Guardia Folding. $3\frac{1}{2} \times 2\frac{1}{2}$ plates and $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film in adapter. F/4·5 Dallmeyer to F/2·9 Ross Xpres.

58 to 64. Adams Minex. $3\frac{1}{2} \times 2\frac{1}{2}$ plates and packs or $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film in adapter. F/4·5 Ross Xpres to F/5·5 Ross Combinable. Tropical model 20 extra. Three larger sizes to 90, and folding models.

III. Twin Reflex coupled focussing

8 to 21. Zeiss Ikon Ikoflex II. $2\frac{1}{4}\times2\frac{1}{4}$ on 20 film. F/4·5 Novar to F/3·5 Tessar. Sector.

10 to 14. Foth Fothflex. $2\frac{1}{4}\times2\frac{1}{4}$ on 20 film. F/3·5 to F/2·5 Foth. Focal plane.

15 to 17. Francke and Heidecke Rolleicord. 6×6 cm. on 20 film. F/4·5 to F/3·5 Zeiss Triotar. Sector.

18 to 19. Voigtländer Superb. $2\frac{1}{4}\times2\frac{1}{4}$ on 20 film. F/3·5 Skopar and Heliar. Sector.

25 to 31. Francke and Heidecke Rolleiflex. 6×6 cm. on 20 film. F/3·5 Zeiss Tessar. Sector. Also 26. 4×4 cm. on 27 film. F/2·8 Tessar. Also 1938 model with some refinements.

65 to 87. Zeiss Ikon Contaflex. 36×24 on 35 mm. film. F/2·8 Tessar to F/1·5 Sonnar. Focal plane. Built-in exp. meter. Also screen.

IV. Range-finder coupled focussing

8 to 20. Ensign Autorange. $3\frac{1}{4}\times2\frac{1}{4}$ or halved on 20 film. F/4·5 Ensar to F/3·8 Tessar. Sector. Bellows.

17 to 21. Voigtländer Range-finder Bessa. $3\frac{1}{4}\times2\frac{1}{4}$ or halved on 20 film. F/3·5 Helomar and Heliar. Sector shutter. Bellows.

18 to 43. Leitz Leica. 36×24 mm. on 35 mm. film. F/3·5 Elmar to F/2 Summar. Focal plane. Scale focussing with separate range-finder on less expensive models. Solid.

19 to 29. Zeiss Ikon Super Ikonta. Many models for 27, 20, and 16 film. F/4·5 to 2·8 Tessar. Sector. Bellows. Also screen.

19 to 28. Zeiss Ikon Super Nettel. 36×24 on 35 mm. film. F/3·5 to 2·8 Tessar. Focal plane. Bellows.

20 to 40. Ensign Multex II. 3×4 cms. on 27 film. F/3·5 Ensign Multar to F/2 Zeiss Sonnar. Focal plane. Solid.

20. Kodak Regent. $3\frac{1}{4}\times2\frac{1}{4}$ or halved on 20 film. F/4·5 Tessar. Sector. Bellows.

29 to 32. Zeiss Ikon Nettar. 36×24 on 35 mm. film. F/3·5 to F/2·8 Tessar. Focal plane. Solid.

30. Le Coultre Compass. 36×24 mm. on plates and roll films. F/3·5 Kern. Sector. Solid. Built in exposure meter. Also screen.

31 to 78. Zeiss Ikon Contax. 36×24 on 35 cine film. F/3·5 Tessar to F/1·5 Sonnar. Focal plane shutter. Built in Helios meter some models. Also screen.

V. Scale focussing bellows cameras, sector shutters

2 to 11. Ensign Selfix 20 and 220. $3\frac{1}{4}\times2\frac{1}{4}$ or halved on 20 film. F/7·7 Ensar to F/4·5 Tessar.

3 to 10. Zeiss Ikon Nettar. $2\frac{1}{4} \times 1\frac{3}{4}$ on 20 film. F/6·3 to F/4·5 Nettar. Another $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film. F/7·7 Nettar to F/3·5 Tessar. Also screen.

3 to 10. Voigtländer Bessa. $3\frac{1}{4} \times 2\frac{1}{4}$ or halved on 20 film. F/7·7 to 3·5 Voigtar.

4 to 8. Kodak Six-20. $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film. F/6·3 to 4·5 Kodak.

6 to 7. Agfa Speedex. $3\frac{1}{4} \times 2\frac{1}{4}$ on 20 film. F/4·5 Apotar and Solinar.

7 to 16. Zeiss Ikon Ikonta. Many models for 27, 20, and 16 film. F/4·5 Novar to F/3·5 Tessar.

11 to 14. Kodak Retina. 36×24 on 35 mm. film. F/3·5 Schneider or Tessar.

MOVING PICTURE CAMERAS FOR 16-MM. FILM

The frame of the picture on 16-mm. film is about 10 by 7·5 mm. which with the standard lens of 1 inch or 25·4 mm. focal length gives an angular field of about 23° by 17°. The normal rate of exposure is 16 frames per second, but most cameras can be set to other rates, slower for poor light, quicker for slow-motion pictures. The normal shutter speed is 1/25 to 1/30 sec. for rate 16/s and few cameras can vary the exposure at this rate. When the rate is changed the exposure is therefore varied proportionally, and aperture of lens must be calculated for this factor as well as for the light and the emulsion speed. A film of 50 feet runs for about 2 minutes at 16/s.

Lenses have a low ratio F/A and are therefore expensive. Better cameras have turret heads or sliding panels in which additional lenses of longer focal length for close-up pictures may be mounted.

The film is driven by clockwork motor and sometimes also by hand; beginners often let the clockwork run nearly down, reducing the rate and thus making apparent motion too rapid when projected.

The film is bought loaded in cassettes, and some cameras require special cassettes, supplied by certain makers only, and not always stocked by dealers in smaller or more distant towns. Film is on non-inflammable stock, which may be sent back by post to processing stations and the cost of processing is usually included in price of film: of the order of 14*s* to 17*s* 6*d* for 50 feet plain and 22*s* 6*d* for Kodachrome. The result is a single positive, which may be copied; but at time of writing (December 1937) copying Kodachrome is in the experimental stage.

Some of the cameras now on the market are briefly described below

with details in this order: Price to the nearest pound; maker and name of model; maximum aperture of lens, name of maker, and focal length; turret or slide; rate in frames per second; drive motor or hand; loading capacity in feet; and note of special cassette.

19 to 25. Ensign Auto-Kinecam Model 6. F/2·8 Taylor Hobson or F/1·5 Dallmeyer 1 inch. 8, 16, and 32/s. Motor and hand. 100 feet.

20. Cine Kodak Model B.B. F/1·9 Kodak 1 inch. 16/s. Motor. 50 feet.

23. Bell Howell Filmo 121. F/2·7 Cooke 1 inch. 16 and 24/s. Motor. 50 feet. Special cassette.

26. Siemens Model B. F/2·8 Busch-Glaukar 20 mm. 8, 16, and 64/s. Motor. 50 feet. Special cassette.

30. Cine Kodak Model K. F/1·9 Kodak 1 inch. 8 and 16/s. Motor. 100 feet.

40 to 43. Siemens Model F. F/1·9 or F/1·5 Dallmeyer 25 mm. 8, 16, 24, and 64/s. Motor. 50 feet. Special cassette.

41. Cine Kodak Magazine. F/1·9 Kodak. 8, 16, and 64/s. Motor. Special cassette with Kodak emulsion only.

45. Victor Model 5. F/2·9 Dallmeyer 1 inch. Triple turret. 8, 16, 24, 32, and 72/s. Motor and hand. 100 feet.

45 to 50. Ensign Kinecam Model 8. F/2·8 Taylor-Hobson or F/1·9 Dallmeyer 1 inch. Triple turret. 8, 12, 16, 32, and 64/s. Motor and hand. 100 feet.

50. Siemens Model C. F/1·5 Siemax Meyer 20 mm. 8, 16, 24, and 64/s. Motor. 50 feet. Special cassette.

51 to 55. Paillard H16. F/2·9 or F/1·5 Dallmeyer 1 inch. Triple turret. 8, 16, 32, and 64/s. Motor. 100 feet.

77. Bell Howell Filmo 70 DA. F/2·7 Cooke 1 inch. Triple turret. 8, 12, 16, 24, 32, 48, and 64/s. Motor and hand. 100 feet.

95. Siemens Model D. F/1·5 Meyer 25 mm. Sliding plate. 8, 16, 24, and 64/s. Motor. 50 feet. Special cassette.

99. Zeiss Ikon Movikon F/1·4 Zeiss Sonnar 25 mm. 12, 16, 24, and 64/s. Motor 100 feet. Coupled rangefinder.

130. Cine Kodak Special. F/1·9 1 inch and F/4·3 3 inch Kodak. Triple turret. Rate continuously variable. 8/s to 64/s. Motor and hand. 200 feet.

CHAPTER XIV. METEOROLOGY

Based on the chapter in the 10th Edition by Dr. Hugh Robert Mill, with additions

TRAVELLERS may add to knowledge of atmospheric conditions by:

(1) Recording each day the readings of simple instruments at fixed hours, and observations on weather made without instruments.

(2) Studying how the changes of instrumental readings allow forecast of the weather and give warning of storms.

(3) Studying the local climate, not by long-continued observation with instruments, but by observing snow-lines, flood marks, and evidence of desiccation.

(4) Collecting records made at outlying stations not reported to a central station.

Unless occupied with definite meteorological work, carry as few instruments as possible, but understand them thoroughly and use them faithfully. Take advantage of halts to extend systematic observations, *e.g.* two-hourly, for detection of diurnal periods.

NON-INSTRUMENTAL OBSERVATIONS

Record in rough note-book on the march with other subjects, but separate out when copying into journal each evening.

Wind in forest or narrow valleys has little relation to that in the open country, but movement of any low clouds visible gives the latter; estimate direction and describe sufficiently by the eight principal points of the compass, North, North-east. . . . Record sudden changes in direction, valuable indications of weather changes. Look for regular diurnal variation of wind direction, even in perfectly settled weather.

Wind is named by the direction from which it blows and its force estimated on the scale Calm, Light, Moderate, Fresh, Strong, and Gale. Marching in a strong wind always uncomfortable, in a gale very difficult. If impossible to march or to pitch tents call it a hurricane after it has passed: if note can be made without shelter at the time, it is not a hurricane. Wind just sufficient to make white crests on waves in lake or river is fresh. If spray blown from the crests it is strong. Unless traveller has long training, one cannot assign to

such observations relative numbers or convert them into miles per hour for comparison with others. Those who attempt rather greater accuracy than the above may try Beaufort's scale of thirteen numbers from Calm: zero, to Hurricane: number 12, and mean velocity over 90 miles per hour.

Note duration of strong wind and time of any marked change. Observe hours of calm and change in land- and sea-winds of tropical coasts related to position of sun and hour of sunset. Look for similar changes on mountain slopes where the wind usually uphill by day and downhill by night; and in valleys, whether up or down the valley, not often across.

If whirlwinds or tornadoes should occur record the hour of onset, direction of rotation, direction of the movement onwards, and breadth of the belt destroyed. Make similar observations of waterspouts, closely allied to whirlwinds. Record the direction of timber fallen in a past storm. Observe inclination of trees growing on open ground caused by prevailing wind, and difference in wave erosion round uniform banks of smaller lakes due to same cause.

"At Iwanchüan I experienced the worst wind-storm I ever met. Such storms come up suddenly. The first indication of trouble is the darkening sun and clouds of dust on the horizon which lead one to think of a vast city going up in flames and smoke. Howls and shrieks as of demons let loose indicate that the *buran* is approaching at good speed, and before cover can be taken, masses of sand and pebbles are lifted and thrown on man and beast. There is great danger when overtaken by these hurricanes, and I knew a man who lost his life by turning back to catch at his sheep-skin coat which the wind had taken. The whirling sand hid him and he was never seen again. The one broken-down shelter was poor cover, but it was built to resist the elements, for it had no windows and the house was very low, but that night a good portion of the roof went to another part of Gobi. For twenty-four hours the mules could not be watered and large sacks of grain were lifted from the carts, flung about like toys, and in a few moments covered by the sand and lost for ever.

The two great dangers of desert travel are a contrast, the *buran* and the mirage, but they are alike in that each has the power to rob a man of discernment and stability. At the sight of lapping wavelets the thirsty traveller leaves the road, victim of a promise which never fulfils itself, and the effect produced by the wind is that of such utter confusion that I saw one of my companions quite unable to find her way back to her room, which was less than 100 yards away, after she had been knocked down by its force."

Miss Cable. Dzungaria. 84.26.

CLOUD

The usual method of estimating amount of cloud in tenths of the sky covered is difficult even when 30° belt round the horizon is neglected, but at least record when sky is completely overcast or quite clear, and whether clouds form and disappear at regular hours morning or evening.

The kind, elevation, and movement of cloud is more important than the amount. Kind is broadly distinguished under four types:

(1) Cirrus clouds, wisps floating very high, popularly called "mare's tails." Transitional form, Cirro-Cumulus, popularly called "mackerel sky."

(2) Cumulus clouds are heaped, lower surface often horizontal, upper rounded. They are moisture condensing in ascending columns of heated air.

(3) Stratus clouds are low-lying sheets usually seen as thin horizontal layers.

(4) Nimbus is a rather low cloud from which rain is falling, even if evaporated again before reaching the ground.

Cirrus clouds are spicules of ice, all other clouds small globules of water falling very slowly through saturated air and in the higher clouds evaporating on the lower surface before they have time to collect into raindrops. Changes of cloud show changes in the vertical circulation of the air.

Record always motion of clouds overhead; at lower angles the movement is distorted by perspective. Distinguish movements of upper and lower clouds floating at very different heights and often in different directions. Observe particularly the streamer or plume of cloud from peaks of very high mountains and observe carefully the height of the cloud belt on a mountain, often as sharply defined as the snow-line. Photograph clouds for record and especially what is recognized as the normal type.

Clouds resting on the ground are called mist, which wets objects, and fog, which does not. Record time of onset, duration, and density of fog: density of thick fog by measuring number of yards at which a person is visible. Observe behaviour of light mist over water or marshes at certain hours and seasons.

Haze is not due to moisture but to smoke from fires, salt from the sea, dust from deserts or volcanoes, and sometimes to swarms of insects.

FINER CLASSIFICATION OF CLOUDS

A more elaborate classification, devised at successive international congresses, and illustrated in successive editions of the International Cloud Atlas, divides clouds into four families:

High clouds, with mean lower level 20,000 feet above the land, not above sea-level, sub-divided into genera Cirrus, Cirrocumulus, and Cirrostratus.

Middle clouds, with mean upper level 20,000 and lower 6500 feet; genera Altocumulus and Altostratus.

Low clouds, with mean upper level 6500 feet and lower near the ground; genera Stratocumulus, Stratus, and Nimbostratus. The simple Nimbus has been abolished.

Clouds with vertical development, upper level that of the Cirrus, mean lower level 1600 feet: Cumulus and Cumulonimbus.

These genera are further divided into species and varieties distinguished by the adjectives *lenticularis*, *castellatus*, etc. For definitions, descriptions, and illustrations, see 'The Observers' Handbook,' Meteorological Office, London, 1934; or the Outline of Meteorology by Dr. Sverre Pettersen, in the British Empire Edition of 'Air Navigation' (McGraw-Hill Publishing Company, London, 1937) in which the classification is a little different, but there are useful notes on the associated weather: *e.g.*

Cumulus clouds are useful in forecasting. Observe changes in their upper parts. If there are no towers or cauliflower structure, rain is unlikely: if there are towers it may develop. If some of the towers have a veil showing presence of ice crystals, snow, hail, or rain are probable. Thunderstorms develop from clouds of Cumulonimbus type. Wind freshens on approach of storm, blowing towards it; as it arrives the wind changes, blowing out forward from the storm, often with strong gusts.

RAIN AND DEW

Record must be more explicit than "showery day" or "fairly dry." Record time of beginning and end of rain on march and whether heavy or light. Such observations may indicate diurnal period and give definite meaning to the terms "rainy season" and "dry season." Record occurrence of rain at night, and measure with rain gauge.

Judge adequacy of rainfall from appearance of vegetation and variability by flood levels on shores of lakes or rivers or lines of débris drifted inland by flood. Study variation of vegetation with exposure, probably indicating the prevailing wind.

Record time of deposition of dew in evening and of disappearance

in morning; also whether it is small drops separated on exposed surfaces or run together and dripping to the ground.

THUNDERSTORMS AND HAIL

Record the time of occurrence, which frequently shows diurnal period. Record distant lightning without thunder, hail-storms, and size of hailstones, and if they are very large photograph with the scale and describe their structure—whether hard and clear like ice, opaque like packed-in snow, or in layers alternately clear and opaque.

"By this time the fresh snow was already 2 to 3 inches deep, falling heavily, driven by a strong south-east wind. Electric sparks were continuously discharged from any point of clothing and metal. Whenever there was thunder a few miles away, both men experienced a slight shock along the spine."

Daszynski. Andes. 84.219.

SNOW

Record any snow showers in neighbourhood of the tropics and the approximate elevation. On mountains in all latitudes observe position of the permanent snow-line below which snow melts completely in the summer and record how far glaciers descend below the snow-line. Record duration of snow, the depth to which it lies, and its character; whether sleety, lightly felted flakes, or the hard separate ice crystals of extreme climates. Measure the depth of snow as it lies on open ground with no apparent drifting. Enter as "depth of fallen snow" to avoid confusion with "snow-fall estimated as rain"; by the rough rule a foot of snow is an inch of rain.

FROST

Observe the appearance of hoar-frost and of thin ice on exposed water. Visible frost is a useful check on the readings of a minimum thermometer exposed on grass, and the appearance of thaw in cloudy weather a delicate test of air temperature. Always record cases of melting and softening, or of freezing mercury and alcohol.

OTHER OBSERVATIONS

Record any peculiar phenomena, rainbows, especially lunar; haloes; mock suns or moons; aurora; or the electrical discharge on pointed objects called St. Elmo's fire. Pay attention to mirage and other effects of irregular density in the air, both the common mirage which raises land below the horizon into sight, or cuts off the lower levels of headlands or islands, and the more perfect forms described

by desert travellers. An interesting form of mirage is the view of Himalayan snow peaks from aircraft at a great height above the Plains of India. The lower snows are raised to an apparent uniform height, giving a peaked range the appearance of the Victoria Falls.

Record at the end of each day whether it felt hot or cold, relaxing or bracing, close or fresh. Whatever relation such feelings have to instrumental records they express something felt by that complex instrument the human body.

During the operations in Mesopotamia in 1915 mirage was frequent and disturbing. A mound 30 feet high which had served as a point of departure appeared on returning as a tower growing taller and taller: then suddenly collapsing into the mound. Bushes 18 inches high appeared as marching infantry, by combination of mirage with heat shimmer and sand blowing in strong wind. Large birds swimming on water were transformed into a fleet of sailing boats. The planet Venus rising late in the night became a very large lantern shown from a signal balloon. *Notes by Brig.-Gen. R. L. Ricketts.*

INSTRUMENTAL OBSERVATIONS

Read twice daily the barometer, and the dry and wet bulb thermometers properly screened; once, in the morning, the screened minimum thermometer and the maximum if in camp; once a day or so the rain gauge. Self-recording barographs and thermographs are useful supplements, but delicate and do not always travel well. The observer must understand enough about his instrument to judge what precautions used at fixed observatories are unnecessary in the field, but at the same time to neglect nothing necessary to secure what accuracy is possible.

"Meteorological readings, dry and wet bulb thermometer, maximum and minimum thermometers, snowfall, hoar frost, wind force and direction, and ablation were made at 07.00, 12.00, and 17.00 G.M.T. daily at the Base between 15 August 1935 and 20 August 1936; at the Central Ice Cap Station between September 1935 and mid-June 1936; at the Northern Station between 1 November 1935 and 1 March 1936, and at Murchison Bay between 25 April and 25 July 1936, as well as on all journeys. Full records of temperature, pressure, and humidity were taken by self-recording instruments at all three stations. Between September and May reports were wirelessed three times daily to the Norwegian Government Station at Bear Island. Measurements of radiation at low altitude were made at the Central Ice Cap Station, but the prevailing cloud and bad weather handicapped this work.

TheStevenson screen was of the ordinary type, and gave considerable trouble, especially during the long periods in late spring when the tempera-

tures were near freezing point. The louvres allowed the snow to collect inside whenever drifting occurred, which over the winter was almost continuously. In cold weather it could be cleared out easily enough, but under warm conditions it was inclined to form a solid block of ice. The fine drift-snow also found its way into the moving parts of self-registering instruments, thermograph as well as hydrograph, causing gaps in the records. This however could be overcome by a thin gauze screen across the open parts of the instruments, which introduced only the smallest lag. No difficulty at all was experienced in keeping the clocks running under cold conditions, the oil having been removed from them, and replaced by powdered graphite once the temperatures had fallen below zero. The lowest recorded temperature was —39° F. both on February 15 and on March 29. Between the two it rose as high as 24° F. on March 21." *Glen. North East Land*. 90.218.

"One of the chief objects of the expedition was the study of the breeding seasons of animals in a climate which varies very little during the course of a year. We set up an elaborate meteorological station at Hog Harbour, designed to measure the climate as it effects animals and plants: that is, we studied climate from the point of view of the biologist. Maximum and minimum temperatures were taken daily, not only under standard conditions of exposure, but also in the forest, where we had a special station at which daily readings were made of humidity and of the cooling power of the atmosphere as shown by the wet and dry bulb katathermometer. A Livingston evaporimeter was also set up in the forest, but so little evaporation takes place in that humid region that only monthly readings were necessary. Sunshine and rainfall and grass-minimum temperatures were measured in the open with standard exposures. Measurements of ultra-violet light were made with the tubes exposed in a new way. Barometer readings were also made. Bird and I standardized a method of measuring twilight on moonless nights, which would, we believe, give interesting results if tried in different parts of the world. A black board with a white circular patch painted on it in enamel paint was erected vertically facing west in an open space. The observer stood 20 metres away and noted the time at which it became no longer possible to see the white circle steadily. We found that different observers only differed by a few minutes. The enormous mass of meteorological data will take some time to analyse, but it is clear that the seasonal variation in climate is small. There are many regions in the world where temperature does not vary very much during the year, but in these there are nearly always distinct wet and dry seasons. Here, in the Northern New Hebrides, it is always hot and wet." *J. R. Baker. New Hebrides*. 85.212.

THERMOMETERS

All thermometers should be divided into degrees by marks engraved on the stem or on a slip of enamel within the outer tube, and should have a National Physical Laboratory certificate. No thermometer is passed if its error approaches one degree, so that for ordinary description a certificated thermometer is correct, but when

the observations are being critically discussed the correction is important. The actual readings of all instruments must be recorded on the spot; all corrections are to be applied afterwards in the discussion. Record in the observation book the N.P.L. number of the thermometer or other instrument, and show clearly any replacements. Use the same thermometer for the same purpose as long as possible and have them re-examined on return. A copy of the original certificate should have been left in safe keeping at home.

In choosing thermometers consider whether low temperatures expected should indicate use of alcohol rather than mercury, and also whether they have sufficient range for high temperatures to be expected, especially when packed for travel.

The Fahrenheit scale of 180° between freezing and boiling, and freezing point 32°, is generally used for meteorology in English-speaking countries, and Centigrade scale almost everywhere else. The graduation is usually to single degrees, and the observation made by estimation to tenths. Readings above zero have generally the positive sign understood; readings below zero are distinguished with the minus sign. The beginner must pay attention to the change in direction for estimating tenths.

Carry unmounted thermometers in brass or vulcanite tubes with a screw top lined with indiarubber and a cushion of cotton-wool for the bulb to rest upon. Thermometers mounted in wooden frames should be packed so that the frame is held firm and the end with the bulb projects into a space which may be lightly filled with cotton-wool.

Vibration and sudden shocks may break the mercury column and drive a part of it to the top of the tube, which should therefore be visible, so that a separated part should not be overlooked. To repair a broken column invert the thermometer with gentle shaking until the mercury flows from the bulb and fills the tube; the column will then usually unite. If not, hold by the upper end, raise to the full stretch of the arm and swing downwards through a wide arc with a steady sweep.

THERMOMETER SCREENS

The Stevenson screen with louvred sides and a door opening away from the sun is good for fixed stations in temperate countries but too cumbrous to carry and unsuited for the tropics. For travelling

carry a bamboo frame holding the thermometers with their bulbs 4 feet above the ground and protect from sun and rain with a kind of partial tent set up in the shade, or if in the sun with a thick mat stretched above the roof. For more permanent stations the thermometers may be placed in a galvanized iron cage kept locked and suspended under a thatched shelter, giving protection from sunshine and rain but ample ventilation. The floor of either shelter should not be bare, but covered with grass or low shrubs to avoid radiation from the ground.

Such a screen is necessary for maximum and minimum thermometers but not for a single observation of air temperature. If air is drawn rapidly past the thermometer or the thermometer moved rapidly through the air, the true air temperature is obtained even in the sun; but shade is better.

SLING THERMOMETER

An unmounted thermometer with cylindrical bulb and the upper end formed in a ring to which a 2-foot silk cord is tied secured by two clove hitches round the top of the thermometer stem, as well as to the ring, to hold the thermometer if the ring breaks. Take a loop of the string round the finger and whirl in a vertical circle a dozen times. Read, swing again, and repeat until the readings are constant, which is the true temperature of the air. Choose a suitable open place in which to swing.

MINIMUM THERMOMETER

The bulb is filled with alcohol or other clear fluid and an index of dark glass shaped like a double-headed pin lies in the column of spirit in the stem. The thermometer is hung horizontally, and the spirit, when temperature rises, flows past the index without disturbing it, but surface tension brings back the index as temperature falls. Consequently the upper end of the index remains at the point in the tube to which the column has fallen. To reset, tilt the bulb end upwards and the index slides along the tube until brought up by the surface tension of the column.

The index should be so long that it cannot sink wholly into the bulb if the instrument is held vertical. If the column of spirit becomes divided by shaking or evaporation into the upper end of

the tube, grasp at the upper end and swing downwards. If the index has been shaken through the top of the column or if a little spirit volatilized to the top is not brought down by the first swing, hold by the bulb end and swing till the index is immersed or the drop joined to the column; then swing from the upper end. Afterwards hold the thermometer vertically to let spirit on the sides of the tube drain back into the column. The end of the column should always show the same temperature as the dry bulb. If it is lower look for spirit condensed at the end of the tube.

Expose a minimum thermometer under a screen not open to the sky and with ground under the shelter covered with grass or leaves. The temperature close to the ground open to sky is often much lower than that of the air a few feet above ground. For ground frost a minimum thermometer is exposed just above the surface.

MAXIMUM THERMOMETERS

They are filled with mercury with a short length near the top of the column separated with a small bubble of air; or better, with a constriction in the tube near the bulb which breaks the column when temperature falls; in either case a portion of the column will be left standing in the horizontal tube when the mercury begins to fall and the upper end reads the maximum temperature. To set the former kind, tilt the bulb end downwards so that the detached column runs back. To set the latter hold vertically bulb downwards and shake, or if necessary tap the lower end of the frame against the palm of the hand; this causes the mercury to re-enter the bulb. When it is set the top of the column should read the same as the dry bulb thermometer.

WET AND DRY BULB THERMOMETERS

The wet bulb thermometer is an ordinary thermometer whose bulb is covered with clean muslin kept moist by a piece of cotton lamp-wick dipping into water quite pure and free from salt. When the air is much below freezing point remove the muslin, wet the bulb, and allow the water to freeze upon it. To assist evaporation from the solid ice it is safer to use it as a sling thermometer. If there is no screen the wet bulb thermometer may always be slung with a muslin cap on the bulb tied with a piece of wet lamp-wick coiled round the upper part of the bulb; or twist blotting-paper round the bulb and dip

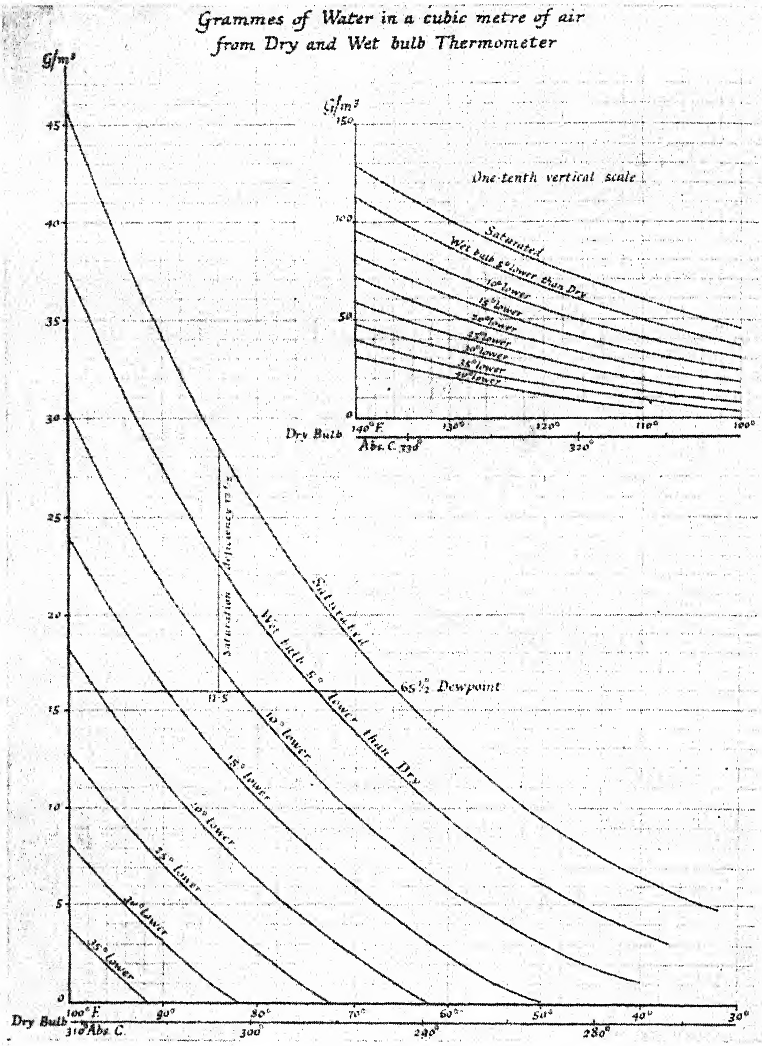
it in water before slinging. Keep it wet until the reading becomes constant.

Compare the wet bulb reading with the ordinary air temperature shown either by a thermometer hung in the screen at least 6 inches away or swung as described.

The difference between the readings of the wet and the dry bulb determines the humidity of the air or the additional amount of water-vapour it could take up before becoming saturated at the existing temperature. The higher the temperature the more water-vapour can be taken up by the air and consequently the relative humidity must be calculated from the air temperature and the difference between that and the wet bulb reading. Thus if the difference is 4° and the dry bulb or air-temperature reading is 50°, the tables give relative humidity as 73 (percentage of saturation); if the air temperature is 70° the relative humidity is 78. For reducing systematic observations there are extensive tables: the diagram is enough for use in the field. (See p. 268.)

When it is a question of interpreting these results to determine how fast things will dry in given conditions it is better to know the saturation deficiency, which is conveniently expressed as the number of grammes of water that one would have to add to a cubic metre of air to saturate it, the temperature remaining constant. If two lots of air have the same saturation deficiency, similar objects will tend to dry at the same rate in both, although the temperatures of the two may be different. Dr. J. R. Baker has invented two convenient nomograms for showing graphically the saturation deficiency from the temperature and relative humidity, or directly from the readings of the wet and dry bulbs. And these diagrams conveniently read by a sliding cursor can be obtained from Messrs. Casella, Regent House, Fitzroy Square, W.1, at 25*s* 6*d* each. (See *Journal of Animal Ecology*, Volume V, pp. 94–96, May 1936, for description of how to use this method to obtain an index of drying power proportional to the drying power of the atmosphere by exposing the thermometers in the draught whose drying power is to be measured.)

The Aspiration Psychrometer is a convenient but expensive instrument requiring no screen, avoiding the risk of the sling thermometer, and giving close approximation to the true temperature and humidity. Air is drawn by a fan through separate tubes enclosing the wet and dry bulb thermometers. The fan is worked by clockwork for five minutes. Hang the instrument or hold in the hand


Grammes of Water in a cubic metre of air
from Dry and Wet bulb Thermometer
G/m³
45
40
35
30
25
20
15
10
5
0
G/m³
150
100
50
0
One-tenth vertical scale
Saturated
Wet bulb 5° lower than Dry
10° lower
15° lower
20° lower
25° lower
30° lower
35° lower
40° lower
Dry Bulb
140° F.
130°
120°
110°
100°
Abs. C. 330°
320°
Saturation deficiency 12·2
Saturated
Wet bulb 5° lower than Dry
10° lower
15° lower
20° lower
25° lower
30° lower
35° lower
65½° Dewpoint
11·5
Dry Bulb
100° F.
90°
80°
70°
60°
50°
40°
30°
310° Abs. C.
300°
290°
280°

preferably in the shade. If either thermometer is not steady when the clockwork runs down, wind it up again. (Assmann Psychr.)

MOISTURE CONTENT OF THE AIR

With the units used in Hygrometric Tables (M.O. 265) the vapour pressure in millibars of the moisture content is

saturation pressure *minus* A (dry *minus* wet bulb F.)

the constant A depending upon the speed of the air passing over the wet bulb. For still air it is said to be 0·677; for gentle breeze as in the Stevenson screen with a moderate wind outside 0·444; for the strong current of the Assmann instrument 0·368. The value 0·444 is used in the M.O. table, and in calculating our graph: the process cannot be very accurate if it depends so much on the precise circumstances of the wet bulb.

The moisture content in grammes per cubic meter is then

216·7 × vapour pressure/dry bulb on the absolute scale

so that the Fahrenheit readings must be converted in this calculation by the formula

absolute temperature $= 273^\circ + 5(\text{dry bulb F}^\circ - 32)/9$

From these figures the graph has been calculated. On the vertical through the dry bulb temperature Fahrenheit (horizontal scale) interpolate for the depression of the wet bulb (plotted for every 5°). A line from this point carried left horizontally to the vertical scale gives the moisture content in grammes per cubic metre. Carried to the right to cut the saturation curve it gives the dew-point from the horizontal scale below. The vertical distance of the point below the saturation curve gives a measure on the vertical scale of the saturation deficiency; and the proportion of the height of this point above the base line to the height of the saturation curve is the relative humidity.

The curves are broken off about the point where the wet bulb reads 32°: there is a discontinuity here as it becomes coated with ice.

Thus, as shown on the graph, for dry bulb 84° F. and depression of wet bulb 11°·5 the moisture content is 16 g/m3; the dew point is $65\frac{1}{2}^\circ$; and the saturation deficiency, which is a measure of the drying power, is 12·5 g/m3. The dew point given by the graph is a degree

or two lower than that given in the Hygrometric Tables, presumably from some discrepancy in the constants somewhere; but the difference is negligible in the field. The tables on which the graph is constructed are calculated for atmospheric pressure 1000 millibars $=29{\cdot}53$ inches. At high altitudes and low pressures the result should be reduced proportionally to the pressure.

A slide rule for these calculations, designed by Mr. E. G. Bilham, and described in *Meteorological Magazine* (Dec. 1935, 70.254) is made by Casella.

RAIN-GAUGE

The rain-gauge is a copper funnel to collect the fall, a bottle to contain what is collected, and a measuring glass graduated according to the size of the funnel to give the depth to which the rainfall would lie on level ground if none soaked in, evaporated, or ran away. Smallest serviceable rain-gauge is 5 inches in diameter. Place in open situation unsheltered by trees or buildings and fix firmly between three wooden pegs with mouth level and rim of the funnel 12 inches above the ground. Carry a spare measuring glass, and for additional safety brass measures with capacity of two-tenths and one-tenth of an inch measured rainfall. Read the gauge at a fixed hour each morning if in camp for more than twenty-four hours; otherwise record the hours of exposure and reading. Melt snow by warming the gauge and measure as rain, and try to measure also the depth of the snow which has fallen at stations over a wide area.

BAROMETERS

Pressure of the air is most accurately measured by a mercury barometer whose size, weight, and fragility make it unsuitable for travel. It will be carried only by expeditions whose special business is meteorology. If accuracy essential and mercury barometer must be carried, consult the instrument makers on most portable form, such as the Collie-Deasy barometer. The Aneroid barometer is much less accurate but very portable. It depends upon the change of shape of a thin partially exhausted metal box as the external pressure changes. Construction much improved of recent years since the instrument used for determining height in aircraft. Tap very gently before reading to relieve constriction in the train between

compression chamber and index needle, and compare at any opportunity with standard mercury barometer.

Readings of barometer made every two hours in camp give information on normal daily range of atmospheric pressure. On the march they give only combined effect of changes due to weather and to altitude.

The boiling-point thermometer determines the pressure of the air independently, since water boils at a temperature depending upon pressure: much less liable to derangement than the aneroid, and consequently a valuable check upon it.

The mercury barometer (to which the aneroid is referred as standard) may be graduated in inches, or in millimetres, or in millibars. The last is the more logical, since it is a unit of pressure, not of length, defined by

one millibar = 1000 dynes per square cm.

A pressure of 1000 millibars corresponds to a height of the mercury barometer 29·531 inches or 750·1 millimetres.

FORECASTING THE WEATHER

Prediction requires knowledge of simultaneous barometer readings over a wide area reported by telegraph or wireless to official departments who make the forecasts distributed by wireless. Such prediction impossible for an isolated traveller, but readings of barometer nevertheless of greatest value as indicating approaching storms.

Storms of wind and rain breaking up steady weather are usually associated with centres of low pressure towards which wind blows in from every side. These depressions or cyclones move in more or less regular tracks and the winds rotate about their centres, with strength depending on the barometric gradient: the steeper the gradient the stronger the wind. So when a depression passes over an observer the more rapidly the barometer falls or rises the stronger the wind to be expected. The winds are inclined inwards round the centre, clockwise in the southern hemisphere and counter-clockwise in the northern. In the centre it is relatively calm but at sea there may be heavy waves from the surrounding gales.

In contrast to the depression or cyclone is a system of high pressure with wind blowing out on every side: the anticyclone, which may become well established and last for days or weeks without

change, with dry calm weather. The winds circling outwards from an anticyclone rotate clockwise in the northern hemisphere and counter-clockwise in the southern.

When the barometer rises slowly and steadily it is probable that an anticyclone is establishing itself and the weather may continue fine even after a gradual fall begins. A sudden fall of the barometer is always a sign of wind and usually of rain. As it falls the wind increases in force, then diminishes, or may change its direction as the centre of the depression passes. With an ensuing rapid rise there is always strong wind but not so often rain.

Signs of rain differ much in different places and require local knowledge and study. If the wet and dry bulb thermometers read nearly the same it may indicate rain or alternatively mist. Low clouds on the hill sides show that the temperature is there below the dew-point. The increase of Cirrus cloud in a clear sky with a falling barometer signifies an approaching depression, as do solar or lunar haloes.

On the western coasts of temperate continents exposed to the prevailing sea winds the weather is usually governed by a succession of cyclones deep or shallow, with anticyclonic intervals between. But over the greater part of the earth's surface the weather is much more uniform and governed principally by seasonal changes.

"It had, he stated, been an exceptional summer. The monsoons both in the Arabian Sea and in the Bay of Bengal had been late in starting. Nevertheless the total rainfall in Burma, Assam, and Sikkim were above the normal. On our way back to Gangtok we ourselves witnessed spoilt crops, soil washed away, landslides, damage to roads and destruction of bridges—all the features of excessive rainfall. On the other hand, Calcutta and Lower Bengal were markedly short of rain. These varied phenomena can be linked up by showing them to be caused by the exceptional strength of the westerly Himalayan wind-current, which, persisting throughout the summer, diverted the whole body of the Bay monsoon away towards the east. For the Mount Everest district this meant a weakening of the Bay monsoon to almost negligible proportions. The greater part of the precipitation in that district is normally caused by the Bay monsoon. Actually the two branches of the monsoon, that from the Arabian Sea and that from the Bay of Bengal, meet in the neighbourhood of Mount Everest. The persistence of the north-west wind this year prevented, at all events in July, anything but occasional carry-overs from the Arabian Sea reaching our district. The August period was more normal; the presence of the depression south of the Himalaya induced monsoon air into the region. But as soon as that depression moved eastwards and filled in the north-west wind re-established itself and brought fine weather."

Spender. M.E.E. 1935. 88.298.

BROADCAST FORECASTS

The development of long-distance flying has required great developments in the strength and organization of official meteorological stations and broadcast weather forecasts in considerable detail give travellers in many parts of the world a new facility. It is therefore worth while to study in the official handbooks of instructions the form and content of the broadcast reports and forecasts.

CLIMATE

The air moves because the sun's heat falls unequally on different places and at different seasons. There is first a daily change with maximum temperature two or three hours after noon and minimum just before sunrise. The daily range, or difference between maximum and minimum, is least nearer the sea or in wet regions (maritime climate) and greatest in the interior of continents, especially where rainfall is slight (continental climate). Diurnal changes of pressure are small except in the tropics, with range up to 0·1 inch with two daily maxima at 10 hours and 22 hours and two minima at 04 and 16 hours. Thus in the tropics the barometer may fall as much as one-tenth of an inch regularly between 10 hours and 16 hours without indicating the approach of a storm or an ascent of 100 feet.

The wind usually blows up a mountain side or a steep valley during the day and down during the night. On the shores of sea or great lakes the wind blows from water to land in the day and from land to water at night, because the land is warmed and cooled by radiation and warms or cools the air much more than water does. There are similar daily periods in the amount of cloud, the saturation of the air, rainfall, and thunderstorms.

The annual change in position of the sun north and south of the equator produces seasonal changes of temperature larger than the diurnal and with greater annual range, except in the tropics, where the noonday sun is always high and the length of day or night varies little. Nearness to the sea is a controlling factor; for example the mean temperatures of July and January differ about 23° F. in the Lofoten islands and 120° in the same latitude in the centre of Asia. The extremes of temperature almost everywhere are in January and July.

Annual changes in pressure and wind are equally marked in tropical and sub-tropical regions. A belt of low pressure lying under the

vertical sun moves northward in the northern summer until July and returns southward after the sun until January. It is a belt of calms, the doldrums, and of rain. Along the mean position of this belt of low pressure, where it passes over a place twice in the year, there are two rainy seasons.

North and south of the low-pressure belt are belts of high pressure from which the trade-winds blow towards the equator, and the westerly anti-trades towards the Poles. These also have annual changes, but the distribution of land and sea has a greater influence than a difference of latitude. The greater heating and cooling of the land between summer and winter causes wind from land to sea in winter, from sea to land in summer.

Generally speaking in a given latitude the air is cooler where the pressure is greater and winds blow out in every direction towards the warmer areas of low pressure.

Distribution of rainfall on land depends on the configuration of the surface in the direction of the wind. A rain bringing wind deposits its rain on the windward slopes and passes over the range as a dry wind giving little rain beyond.

"The new policy is clearly dictated by the desire to make the watershed the frontier; hence the misgivings and complications when the Tibetans cross the passes and settle on the Burmese side of the frontier. But obviously a pass of 15,000 feet is nothing to a Tibetan, who habitually lives at 10,000 or 12,000 feet altitude. The Tibetan is not stopped by physical, but by climatic barriers; and no boundary pillars are needed to make him respect these. His frontier is the verge of the grassland, the fringe of the Pine forest, the 50-inch rainfall contour beyond which no salt is (until indeed you come to the sea), or the 75 per cent. saturated atmosphere. The barrier may be invisible; but it is a far more formidable one to a Tibetan than the Great Himalayan range. If he crosses it, he must revolutionize his mode of life. It is just here that the maps of mountainous frontier regions are apt to convey a false impression. These invisible barriers, so thoroughly respected by simpler civilizations than our own, cannot be depicted on an ordinary map, which unconsciously fixes our attention on mighty ramparts of rock." *Kingdon Ward.* 80.469.

These climatic questions are illustrated on maps more easily than described in words; but remember that the generalized representation of mean conditions on small-scale maps are little guide to the weather to be expected at an individual time.

Isothermal Maps represent the distribution of temperature by lines analagous to contours drawn through the places where the temperature reduced to sea-level is in the mean the same in a par-

ticular month. The distribution on a particular day in a particular January will often be very different.

Moreover the temperature has been reduced to sea-level by applying a correction of 1° F. for every 300 feet of altitude. Such reduction is necessary; otherwise the isothermal map would in mountainous countries be very much like a topographical map. But all the same the isothermal map of the Himalayan regions is with some difficulty converted into a guide to the temperatures one may expect to experience on the mountains or beyond them in Tibet. The isothermal maps give in fact a general idea of what the distribution of climate would be at sea-level if the reductions from the observed temperatures at considerable heights really follow the simple law: a degree for every 300 feet.

Isobaric maps similarly show the lines connecting places which have in the mean the same barometric pressure reduced to sea-level during the period for which the map is constructed, month or year. Such maps are more readily interpreted because the observer will reduce his own observations for the barometer to sea-level, before comparing them with others. Isobaric maps are of practical use as giving a probable value of the sea-level pressure at any point for comparison of the readings of the barometer or boiling-point thermometer for finding an approximate altitude. They are useful also because prevalent winds can be deduced roughly from the isobars.

The barometric gradient is the difference in the height of the barometer along a unit of length at right angles to the isobars. The steeper the gradient the closer, therefore, are the isobars and the stronger the wind. The connection between direction of wind and of isobars is conveniently expressed by Buys Ballot's law. If you stand with the lower pressure on your left hand and the higher on your right in the northern hemisphere, the wind will be blowing on your back, but in the southern hemisphere on your face. To this one may add that the winds are not generally parallel to the isobars but incline inwards towards the centres of low pressure.

Rainfall maps represent by isohyets the lines along which rainfall is the same. These are actual rainfalls, not reduced to a fictitious sea-level. A map of annual rainfall shows then very clearly the equatorial zone of heavy rain, the belts of nearly rainless desert north and south of the equator, and the gradual change to temperate

zones of moderate rainfall. These maps show the close relation between rainfall, direction of wind, and configuration of the land. With prevailing wind off shore, there is scarcely any rain off the west coast of tropical South America. On the eastern side of the Andes close to the west coast there is heavy rainfall from the sea wind which has come right across the great plains.

Rainfall is both the most important and the most inconstant of the elements and its practical importance in relation to the seasons for agriculture is so great that the rainfall at that place is perhaps best represented by a little profile showing the average fall for each month and the average deviation from the mean.

CHAPTER XV. VEGETATION

By the late Dr. T. F. CHIPP

THE series of papers on The Habitable Globe delivered at the Society's Centenary Meeting, on the demarcation of geographical regions, changes in the earth's surface and climates in pre-historic and historic times, the capacity of countries to support populations and their domestic animals, and ethnological problems generally, were all discussed from the point of view of a study of vegetation. Professor Fawcett in his paper on The Extent of the Cultivable Land remarked that barely one-eighth of the whole land has been surveyed in sufficient detail to estimate the possibilities of cultivation and habitation.

Every traveller can add to our knowledge of the distribution and character of the vegetation of the world simply by entering in the daily diary the type of country passed in each period of each day's march, even if only forest and grassland are distinguished. There are many large areas of the earth for which the natural covering has not been recorded.

Valuable work can be done in little-known tracts by making route traverses of vegetation. Books of travel often contain excellent descriptions of vegetation, but too often the descriptions exasperatingly omit easily observed data necessary to render the record of value. For example, the diary may say: "We awoke early in the morning. It was bitterly cold, the thermometer registering 43° F., and the barometer showed that we were 5500 feet above sea-level. We struck camp about 9 a.m. and then commenced a long climb over granite crags. After about two hours we entered delightful forest country." (Here follows an excellent description of the forest.) But there may be no mention of the geology, soil, elevation, or temperature of the forested region; the day, and even the month of the observations may be uncertain; the elevation and morning temperature (but not the hour) are mentioned, and later the geology, but there is no indication of the vegetation until the forest is entered. Thus the observations as a series are practically wasted for serious purposes.

PLANTS AS INDICATORS

A particular form of vegetation, or species of plant, must indicate that certain conditions, on which they depend, are to be found. Such indicators have varying significance. A high and fairly constant relative humidity of the air is indicated by the abundance of mosses and liverworts on the ground and thickly clothing every rock and tree trunk. A climate with a moderate winter rainfall, mild in winter and hot and dry in summer, is associated with the dominance of trees and shrubs with rather small hard evergreen leaves. A hot and wet climate is denoted by tall evergreen large-leaved trees accompanied by a rich vegetation. Plant communities may also denote the extent of particular geographical regions embraced within a special type of climate.

Change in soil conditions are generally reflected in the vegetation, as in the fringing forest along a watercourse through a grassland country in the tropics. Smaller changes may indicate waterlogging, or strongly acid soil, an area rich in lime, or a change in the physical structure of the soil.

Plants and plant communities indicate clearly the treatment to which a country has been subjected. For instance land which has been overgrazed may be characterized by certain coarse herbs and grasses and the occurrence of these plants will therefore usually indicate the usage to which an area of land has been put and its unsuitability for grazing. Areas which have been subjected to fire are generally readily recognized by the composition and form of the vegetation, and the presence of the "fire-indicators" may give due warning of an impoverished land unsuitable for particular types of economic development, and where the natural development should be preserved to prevent general desiccation of the country. Certain plants native to a locality are seen in association with particular crops. The appearance of these native plants in other areas can reasonably be held to indicate suitable conditions for the extension of these crops.

In forested countries the tree growth, with the shrubs, provides the best indications for appropriate economic development. In brief, the natural plant community is the best and safest indication of the conditions prevailing, and the recognition of indicator plant-communities and species proves of first importance in appraising land for particular crops, for afforestation or conservation, for raising different kinds of stock. Such information is of great value to any

Government or body concerned with the development of large tracts of country.

"The only places where close plant communities are found are where there has been manuring in some form or another. The most noticeable of these are below bird cliffs where there may even be a carpet of vegetation similar to West Spitsbergen. These green patches, such as those by the base and below Floraberget in Murchison Bay, are clearly visible from many miles away, standing out in marked contrast to the browns and blacks of the bare rock elsewhere. On a smaller scale more luxuriant plant growth is found round disused eiders' nests, near the edge of tarns (where there has been reindeer and bird manuring), and near pieces of old whalebone which are frequently found up to quite considerable heights."

Glen. North East Land. 90.305.

"One interesting point that seems to have emerged this year is that plants, like animals, have an upward limit beyond which they cannot exist happily. At Camp I, at 19,000 feet, there were about twenty or thirty species of flowering plants belonging to twenty or thirty different genera. None of these existed at Camp II, which was only 1000 feet higher, and even lichens, of which there were three or four species at Camp I, could not be found at Camps II and III. It looks very much as though plants, through lack of oxygen or carbon-dioxide, or moisture, or some such essential, cannot grow above about 20,000 feet." *Wager. M.E.E.* 1933. 83.11.

DESCRIPTIONS OF VEGETATION

Individual plants, and their Natural Families, have been known by Latin names for many years, but confusion still exists among all except the expert botanists in the record of units and types of vegetation. The difficulty is that a traveller will use, indiscriminately, terms between which there is no real basis of comparison or contrast, and the result is that his record is quite useless. A description of a journey through a part of Africa which begins in the "bush," and continues through tropical forest into savannah and high veld is worthless as a record, because the contrasted terms have no comparative value in the country concerned; to be of value it should read that the journey began in evergreen forest, was continued through deciduous forest, into grass-woodland and rolling plains of grass-herbs.

Travellers must use the same set of terms, if any uniform record of the country is to be obtained, and these terms should be self-explanatory, so that any traveller, whether he be scientist or not, can furnish records of value. The terms may be classified thus:

1. Popular names in general use for the same type of vegetation in all parts of the world: mangrove, bamboos, palms, conifers.

2. Popular English names, or names that have been adopted as English, but originally with only regional applications: parkland, orchard country (England); veld, vlei (South Africa); tundra, steppe (Russia); Sudd (Sudan); bunch-grass, savannah, prairie (America); maquis, macchia, macchie (Mediterranean); jungle (India and the East); bush (W. Africa); heath (Europe); brigalow (Australia).

3. Descriptions of the habitat: aquatic, swamp, marsh, maritime, freshwater; montane, mountain; plains, rocky; sandstone, granite; fell-field.

4. Geographical names for vegetation characteristic of definite tracts of country: Sudan, Sahara, Guinea, Indian Plains.

5. Technical terms, used by technical officers, such as foresters: rain (forest), monsoon (forest), desert, tropical (forest), high-moor, temperate (grasslands).

6. Names of the principal and most striking plants in a type of vegetation: botanical, as Acacia, Panicum, Brachystegia, Lophiretum; or vernacular, as Mvule, Mahogany, Salt-bush, Spinifex, Mallee.

7. Terms referring to the principal physiognomic characters of the vegetation:

(*a*) The composition of vegetation: trees, shrubs, bushes, herbs, grasses, sedges, mosses, lichens, mat-plants.

(*b*) The structure of vegetation: closed, spaced, scattered.

(*c*) Types of vegetation: forest, woodland, grassland, grass-woodland.

The traveller is recommended to use the terms of Section 7 as the basis of his description. But even these may be used in different senses by different persons, and also by the same in different parts of the world. It is convenient, therefore, to adopt an empirical scheme for the sense in which these terms are to be used:

(*a*) *The composition of vegetation :*

Woody plants:
- With distinct stems or trunks (including palms and bamboos and woody lianes) .. .. Trees
- Branching from the base:
  - Generally more than 2 feet high .. .. Shrubs
  - As a rule less than 2 feet high .. .. Undershrubs
  - All branches ascending .. .. .. Bushes
  - Lowest stems and branches prostrate on the ground (plants only a few inches high and mostly arctic) .. .. Mat Plants

Plants herbaceous above the ground:	
Leaves thick and fleshy, stems often green and cylindrical, ovoid, angled, or columnar	Succulents
Grasses and grass-like plants	Grasses, sedges, and reeds
Other herbaceous plants	Herbs
In the Arctic and Antarctic the vegetation is largely composed of	Mosses and lichens
When the plants grow so closely together that they touch each other or become interwoven to the general exclusion of other plant covers (layers) beneath them	Closed
When the plants providing the greater part of the ground cover are spaced, but other vegetation closes the spaces between them so that the ground surface is not exposed	Spaced
When the ground generally is bare and plants occur at intervals scattered or solitary ..	Scattered

(*b*) *The structure of vegetation:*

The terms must describe the greater part of the vegetation, not necessarily the most striking feature of the landscape.

(*c*) *Types of vegetation:*

The terms used to denote composition and structure can then be combined to denote types:

Trees closed are Forest; spaced are Woodland with......

Shrubs and Bushes closed are Scrub; Succulents closed are Succulent Scrub.

Mat plants closed are Mat.

Grasses and herbs closed are Grassland; spaced they are Tufted.

The spaced and scattered distributions will be described as Woodland with grasses, Bushes with herbs, Spaced mosses, Scattered shrubs with mat plants, and so on.

To these physiognomic terms denoting the different types of vegetation may be added appropriate terms from other sections, and descriptive phrases will be made such as: African Mangrove forest; montane grassland; scattered bushes of the Sahara plains; swamp grasses and herbs. But generally avoid using popular regional names (Sect. 2), technical terms (Sect. 5), and botanical terms (Sect. 6a).

SURVEY AND RECONNAISSANCE

Besides noting in the diary the vegetation types, mark on a map of the route the vegetation along it and so to make a definite contribution to a vegetation map of the country. A good vegetation map on a reasonably large scale (from 1 : 50,000 to 1 : 1,000,000) is of great value in many ways, which are as yet insufficiently recognized. It presents in graphic form the nature and distribution of one of the most important material assets of every country. Even in the most extreme dry and cold climates it provides indications of first importance to human habitation. The natural vegetation itself may be of direct economic value, as timber or other products which can be directly harvested, or for pasturage; in every case it is probably the best index to what crops, agricultural and forest, may be best grown. For these reasons a good vegetation map is of as much value as a geological map, and, indeed, except where there are valuable mineral deposits, of a good deal more.

Whether it is virgin vegetation or not, great advantage can be gained from mapping it and recording the use to which the land is put. A map not only records what exists, but is also a starting point for the study of changes, whether brought about by human activity or natural causes, and provides for the future some indication whether the correct policy has been followed in developing a country. It also arouses public interest in the wild vegetation, which ought to be recognized as a national possession not lightly to be destroyed or wasted, and indicates the most suitable Nature Reserves or National Parks which every country should possess.

Few countries possess anything like complete vegetation maps, and every traveller may help to make one by preliminary reconnaissance, or general record of the vegetation in a superficial way. Reconnaissance means a line survey of the vegetation and other relevant features, and their record on some kind of map; the scale of 1 : 100,000 is suitable, but the larger the better. If only a scale smaller than 1 : 100,000 is available, prepare enlarged copies to have space for recording the main features of the vegetation by symbol or letter; note the meaning in the margin or on the back of the map. The localities where specimens are collected, photographs typical of the vegetation taken, soil samples collected, or climatic data should also be recorded.

Confine observation to the vegetation on the route, or to

prominent features which can be clearly seen and recognized from it.

Record first the vegetation characteristic of the country generally, at stated intervals on the route. Take special care not to record merely the unusual or striking features, such as little willow patches in the arctic, or groups of palms or bamboos in the tropics; and when such features are recorded state the area they cover, or they are apt to give erroneous impressions of areas as a whole.

Vegetation whose nature is inferred and not directly observed, must always be shown with a query.

Besides the map records, make full notes of everything relevant consecutively in the order of observation; this is better than to keep separate pages for different categories of observations.

The best method of travelling for reconnaissance work is unquestionably walking, though from horseback or from a slowly driven motor car, or steamer, it is possible to make useful notes. Adequate work can even be done from the windows of a slowly moving train. Car window survey, as it has been termed, has its strict limitations, but no method need be despised if its limitations are recognized.

"Our new technique for collecting plants in the Libyan Desert is called high-speed botany. The process is this: When you are passing through bad sandy country, and soft going, you see a plant you wish to collect. You know if you stop the car it may take about half an hour to push it out and also that you will receive the extremely candid opinions of the rest of the party on botany in general and on yourself as a botanist in particular. What happens is that the eager collector leaps out of the car while it is still going, and uproots the unfortunate plant; meanwhile the driver drives round in small circles until the show is over and the collector has jumped in again." *Shaw.* 78.35.

Survey by photography and sketching from the air saves time and gives a complete picture of the ground. But it is difficult to interpret photographs taken vertically downward, except by the help of shadows cast when the sun is low. Oblique photographs from comparatively low altitudes give instructive pictures by which the verticals may be interpreted: but only after training by going over some of the ground and comparing it with the photographs.

Whenever possible, the photographs should have ample overlaps for examination in a stereoscope, which shows the vegetation in relief, and greatly assists the identification of trees among vegetation of homogeneous tone. Single prints should always be placed so that the shadows are cast from the top left of the picture.

ECONOMIC NOTES

Study the distribution and habits of populations, which may explain the denudation of forest country, changes of trade routes, or through political insecurity the abandonment of farming in open country with a consequent change in, or destruction of, the vegetation. The control and destruction of natural vegetation by the pasturing of nomad tribes, the destruction wrought by the hunter firing the vegetation to drive his game, and by the farmer employing fire to clean his ground, furnish important records from which the progress or deterioration of a country can be ascertained over a period of time.

Study the dissemination of fruits and seeds; they may be carried as food, and thus introduced; they may be imported incidentally as ballast with merchandise, or in packing and wrappings. Diseases of cultivated crops can be introduced by the same means. The natural vegetation can be altered by natives giving preference to a tree or plant of economic value, or by removing the timber trees from a mixed forest.

Examine native markets and articles in domestic use, and ascertain the local names and uses, the properties, composition, and commercial value of cereals, vegetables, fruits, oil seeds, gums and resins, fibres, tan, dyes and timber. Collect specimens of the products, trace them to their sources, and secure specimens of the actual plant or tree. Never rely on a native fetching specimens, or showing plants, but satisfy oneself that the plants do actually produce the substances assigned to them. Obtain seeds of decorative or ornamental plants, study their propagation and cultivation, and note their natural habitat.

Record occurrence of pasture, and whether it is of grass, herbs, or shrubs; the season at which it is available, its duration, and what ends its season, are all important. Collect specimens of the most important constituents.

Use discretion in recording the reputed properties of medicinal plants; people often use any and every plant for almost every complaint. It is difficult to distinguish plants which merit serious investigation. A poultice of mud and leaves may be an indiscriminate mixture to which the medicine man ascribes virtues, or it may be leaves of a plant whose genuine properties are well known to natives, not to Europeans.

Poisonous plants always merit attention; if accidentally poisoned make full notes of the parts of the plants with which contact was made, and of their effects. Try to ascertain the constituent plants of arrow poisons and fish poisons, the parts used, and methods of preparation.

Observe the behaviour of plants introduced from other countries, and the local habitat and requirements of plants suitable for introduction to other countries. But do not make general statements from hearsay information without close investigation. Serious financial losses have resulted from reports by travellers who have not verified their information. Trees of value have proved absent from the timber forests reported valuable, and areas have been reported rich in rubber when the majority of the lianes and trees have belonged to plants without latex.

VERNACULAR NAMES

Take great care in recording the vernacular names of plants; when they are written for the first time they should be spelt phonetically on the R.G.S. II System (see p. 216), and names should be printed in block capitals, with the dialect or language in which the plant is recorded. Natives often appear to distinguish plants which belong to the same species, and do not differentiate by name plants obviously of different species; different names are often given to different parts of a plant, especially if such part is credited with medicinal properties. Where the dialect or language changes over short distances, many different names may have to be recorded for the same species. Do not assume that the name given is the name of the language of the country; ascertain what language is being spoken and whether the informant belongs to the local tribe; this especially applies to one's personal attendants. Confusion and failure to trace plants of economic value have arisen from this cause. Popular or trade names should always be used with some qualifying adjective, such as African Mahogany (which is a *Khaya*, not a *Swietenia*) and Kenya Cedar (which is a *Juniperus*, not a *Cedrus*). In some countries where there is no common language an attempt is being made to standardize vernacular or popular names throughout the whole country.

The above is adapted from 'Aims and Methods in the Study of Vegetation,' Tansley and Chipp. The Crown Agents for the Colonies, 4, Millbank, London, S.W., 1926. Price 12*s*. 6*d*.

"Native names were obtained for the great majority of the plants collected, and in a number of cases the meaning of the name was also noted, throwing light on the uses and attributes of the various species. In this connection the writer would like to acknowledge his indebtedness to Major Horsley, whose knowledge of the language proved invaluable.

It was found that, while all the Somali tribes speak the same language, plant names in use by one tribe may vary considerably from those of another, and furthermore that the name of a common plant in one part of the country may be transferred to another species in some other locality.

Speaking generally, the plant names may be separated into two classes, those used by the Darod tribes (Warsangeli, Mijertain, Dolbahanta, etc.) and the Ishaak tribes (Habr Yunis, Habr Awal, Habr Toljalla, etc.). In some cases however it was found that individuals were acquainted with both sets of names, and appeared to use them indiscriminately." *Collenette*. 78.121.

PLANT COLLECTING

Collecting specimens for the herbarium renders direct assistance to those who prepare the great Floras of the world. Properly prepared specimens convey a better idea of the living plant, apart sometimes from general habit and colour, than photographs, drawings, or descriptions. Herbarium specimens are indispensable for reference. Preserved specimens amplify and supplement field notes and descriptions. Comparison of plants from different localities and habitats, or which may occur at different seasons, is possible only from preserved material which can be examined critically. In describing or citing plants it is quite easy to make mistakes; the only certain way of permanent record is to send preserved specimens to one of the great Herbaria.

The commonest plants, with inconspicuous flowers, especially among trees, are often the least known. A few good and representative specimens are in every way better than many scraps. Avoid collecting plants which have obviously been introduced. The Director, Royal Botanic Gardens, Kew, gives advice to any traveller who applies. See also *Hints to Collectors*, sent on application.

EQUIPMENT

The necessary equipment is a collecting portfolio, presses, a waterproof canvas wrap, tins for fruits, some poisoning substance in moist climates, seed envelopes, and field note-books. A collecting tin or vasculum is useful in temperate and windy climates; but transfer plants to the presses frequently or the tin will become full and the specimens mixed.

The collecting portfolio is made of two stout pieces of cardboard, about 2 feet long by 1 foot broad, joined along one of the long edges by a canvas back sufficiently slack to allow easy room for some twenty thick pieces of drying paper laid in loosely; or bind the whole into a large book. Attach a stout canvas strap, about 3 feet long, to a free corner of one card and to the alternate, not opposite, free corner of the other; this keeps the portfolio closed as it is carried slung over the left shoulder and hanging under the right arm. Place each specimen as collected in the portfolio between the sheets, and when it is full halt and transfer the contents, as they are, direct to one of the portable presses. With flowers of delicate texture (*e.g.* iris, orchids), remove two or three from the specimen and press separately in a paper capsule: reassemble the specimens on return to camp. Do not attempt to preserve specimens in liquid.

The press consists of two frames, top and bottom, and sheets of drying paper between, to a depth of about 3 inches. Drying sheets should not exceed the standard size of Kew Herbarium sheets ($16\frac{1}{2} \times 10\frac{1}{2}$ inches). Any kind of thick absorbent paper will do, or unglazed newspaper, two or three sheets together. The frames are of strips of wood or bamboo fastened into a lattice form by sprigs or tacks, with the ends of each strip standing out free beyond the paper. Tie a piece of cord firmly to each corner of the bottom frame, and with the free ends tie to corresponding corners of the top frame, the corners on a diagonal first, or the contents of the press will be squeezed out. Use gentle pressure increased as the specimens dry. Presses should not be too full, and sufficient paper must be put between specimens to prevent their crushing each other. At every opportunity stand the presses on edge in full sun, a few inches apart, for the air to circulate. Change the paper every day, or every few days, according to the moisture content of the specimens; keep all succulent specimens together in one press. Brush the soiled paper, when changed, and spread in the sun to dry, after which it can be used over again. Sheets of corrugated paper at intervals in the press facilitate drying. In the afternoon, while the presses are still warm, wrap in a waterproof canvas sheet and take under cover. Keep this sheet round them on the march, to protect from dew on undergrowth, or rain. During the rains, and whenever there is not enough sun, dry by camp fires, avoiding smoke as much as possible.

Under certain conditions some plants, and most of the fruits, will

show mildew from time to time. Carry a small drum of methylated spirit and tabloids of corrosive sublimate: when required a concentrated solution of sublimate in spirit can be made and applied with a feather. Uneducated natives must be warned this solution is poisonous and made to wash their hands before eating.

Split thick and woody specimens and press the portions separately. Cut or shave fleshy and glutinous specimens if necessary, and steep in boiling water, or some poisonous solution before being put into the press. When specimens stick to the drying paper, put them into the dry press with the sheet and do not attempt to remove them from the sheet until they have dried. Fragile or delicate specimens also should not be removed from the collecting sheet when papers are changed, but transferred intact with the sheet on which they rest; this avoids damage by too frequent handling. Place flowers or small pieces that might easily drop out of the press in little paper capsules, folded from a sheet of newspaper.

Fruits and other bulky material cannot conveniently be packed in presses. Pack them in any tins of convenient size with wide mouths, and firm well-fitting lids. Place the fruits in the tins as they are collected, and at the end of the march open and place the tins with their contents to dry in the sun.

To collect from trees is often difficult; the crown is hidden in the tangled canopy of the forest and the trunk is too big to climb. It is not safe to take fallen flowers as belonging to the tree above them; they may come from a tree farther away or from a liane scrambling through the tops of many trees. Shooting down specimens is expensive, and often the twig drifts in its fall on to the crown of a neighbouring tree. Felling trees is often difficult, for their crowns are laced together by giant lianes, and it may be necessary to cut a dozen to get one to fall. Collect tree specimens, therefore, including tree orchids, ferns, and other plants which live in the tree tops, as opportunity occurs when fellings are taking place for railway construction, for road-making, for new farms, or when windfalls are found.

Pay attention to writing up notes in the field. Many excellent opportunities have been lost by collectors failing to record with the field notes the kind of country, the colour of flowers or fruit, or even whether the specimen is from a tree, shrub, or herb. Record dates of flowering and fruiting, and the locality more precisely than by the nearest town marked on the map. Write a clear legible hand.

After returning to headquarters complete drying the specimens without delay. When dried lay them out on loose sheets of paper dusted with a little powdered naphthalene; tie up tightly in bundles and send by post, a list of the numbers despatched, with copy of the field notes, going under separate cover.

Take care that seeds are properly ripened, and carefully dried before despatch. If they cannot be sent away at once keep them dry and at an even temperature. But use every post to send them in small packets, as soon as they are ready. Sealed tin boxes and glass bottles should not be used. Pack seeds in quantity in ordinary paper or canvas bags and enclose in a wooden box.

Gather bulbs, rhizomes, and tubers at the end of the growing season, and keep dry for a few days until the foliage has withered; then pack in a wooden box with wood shavings, paper, or any light dry material, that will prevent their moving and getting bruised. Straw and hay are liable to mildew. Orchids, which have fleshy pseudobulbs, should be treated and packed in the same manner.

For living plants, cuttings, etc., it is best to seek expert advice: or study *Hints to Collectors* obtainable from the Royal Botanic Gardens, Kew.

Equipment for British Guiana Expedition (*R. W. G. Hingston*)

20 pairs wooden press frames; 20 pairs canvas straps; 4000 sheets Kew drying paper; 500 sheets newspaper for drying specimens; 50 collecting books Kew model; note books; cotton reels; 2 portfolios; garden pruning pole; 40 lb. camphor balls; 1 bottle corrosive sublimate tablets; 1000 small envelopes and seed packets; prospecting knife; field glasses; 3 pocket lenses; 72 flat tins with hinged lids, 3×4 inches and ½ inch deep; 1 ream grease proof paper; B.D.H. capillator; 33 feet tape; 50 foot tape; actinometer; hygrometer; stop watch; trowel; 50 bags for soil specimens; prismatic compass; 100 feet cord; note books of squared paper.

SEED COLLECTING: *by F. Kingdon Ward*

Those whose journeys take them into little-known mountain regions particularly can do a service by sending home the seeds of unusual, useful, or beautiful plants, whereby they may, if not already known, be brought into cultivation. But the non-botanical traveller is up against two difficulties. If the plants are in flower, he will indeed notice them, but will be unable to gather seed of them, unless he

happens to return the same way some months later; if they are not in flower, he may fail to notice them, even though they are in ripe fruit. Only in the tropics are certain plants found in fruit and flower at the same time.

Plants are introduced from one country to another for two reasons: economic, as Brazilian rubber in Malaya, and aesthetic, of which there are abundant examples in Britain. The traveller who discovers or who introduces a new plant of economic value may be, literally, sowing the seeds of a great industry. He who introduces a new garden plant may be conferring benefits less material but deeper on mankind.

Technically anything which contains seeds is a fruit, whether dry like a poppy-head or soft like a raspberry. The word is so used here. When the fruit is ripe the seeds may be extracted; they may be shaken out of a capsule, or if it opens completely they will fall out or be blown out by the wind. Berries contain a few or many seeds; the plum and cherry only one. Seeds which have to retain their viability for several months must be quite ripe and quite dry. Artificial warmth for drying is not recommended: sun heat is far better, and slow drying in the shade best of all.

The beginner is apt to collect seed too early, before the fruit is ripe, rather than too late after all the seed has gone. On the other hand a fruit may be quite green and tightly closed and yet contain ripe seeds; as at the end of the rainy season. Speaking generally, in the northern hemisphere most fruits ripen between October and Christmas; in the southern hemisphere between March and May. In the Eastern Himalaya most alpine plants ripen their seeds before the end of September, except rhododendrons which should be collected from the second half of October onwards.

Collect seeds reasonably clean, *i.e.* without too much débris. Separate by winnowing as the native winnows his grain, by tossing the mixture gently in a large flat circular basket, or on a sheet of paper in a light breeze.

Pack each variety of seed in a separate envelope clearly marked with a number corresponding to a number in the note-book, against which enter the date, locality, altitude and any notes on the plant which might assist in its identification. It saves both time and expense to collect a specimen of the plant: flowers if possible but leaves and fruits (if dry) certainly. This entails a little more equip-

ment but is well worth the extra trouble. Ticket the specimen with the number corresponding to its seed; thus any one receiving the seed under a number can examine at leisure the corresponding herbarium specimen and decide whether to raise it or not. The simple technicalities of drying plants have been dealt with elsewhere in this book.

Envelopes of seed must be tightly packed in tins with press lids. These can be sewn in waxed cloth and mailed to their destination from the first post office. If air mail is available so much the better.

Remember that a very small quantity of seed is required; the beginner especially should never waste his time collecting large quantities which may after all prove valueless. Let him concentrate rather on collecting quality; and in making certain that it is ripe, dry, and properly packed and labelled.

CHAPTER XVI. GEOLOGY

By Dr. Kenneth Sandford

These notes are intended neither for the experienced field geologist nor the prospector, but for the traveller who wishes to make the best use of his opportunities. Some regions are so complex that a trained geologist spends weeks on the ground before he can add appreciably to existing knowledge: but large areas are still geologically unexplored and the traveller can do valuable work by accurate observation, clear notes, sensible collecting, careful labelling of specimens, and good photographs with adequate descriptions of place and direction of view.

The untrained traveller before he starts can best equip himself by attaching himself for a period to a geological department of a university or school of mining, learning the rudiments of geological mapping, and taking part in geological excursions: many are now open to any one interested, thanks to organizations such as the Geologists' Association. Take in the field, with this book, a technical pocket-book, such as the 'Handbook for Field Geologists,' by C. W. Hayes, revised by Sidney Paige (New York, John Wiley & Sons; London, Chapman & Hall, Ltd.: 12*s* 6*d* nett). In these notes no attempt is made to cover the ground of that book. Special handbooks issued by the British Museum (Natural History) and other institutions, should be studied before departure: for general reading, Archibald Geikie's 'Text Book of Geology' (fourth edition). Widely used introductory books are W. W. Watts' 'Geology for Beginners,' and W. M. Hobbs' 'Earth Features and their Meaning.'

The traveller who, though busy with other work, is prepared to collect rocks or make observations here and there may read these 9 precepts, adapted and enlarged from instructions issued by L. R. Wager to members of Watkins' expeditions in Greenland:

1. Collect rock which is in position. Loose blocks of unknown origin, or from screes, are of little value.

2. The outer crust of rocks is usually altered by the weather. Always attempt to include some of the inner fresh material.

3. The best size for specimens is $4 \times 3 \times 2$ inches, but pieces not less than $2 \times 2 \times 1$ are adequate.

4. Wrap each specimen with a slip of paper giving the *exact* locality, so that any one else could go to the place and collect another specimen.

5. Collect specimens of the prevailing rock and not of the exceptional: avoid the tendency to postpone collecting the first until none of it is brought back; exceptional rocks are of little value.

6. If veins or unusual patches or layers are collected, collect also the rock surrounding them.

7. Crystals of quartz and calcite are attractive, but useless unless they have an exceptional number of flat faces. Other crystals are worth collecting, but must be packed very carefully.

8. Fossils should be collected and wrapped very carefully. If more beds than one are fossiliferous keep the collections from each separate and number consecutively from the lowest bed upward.

9. Take as many photographs as possible of rock exposures, cliffs, and general scenery, with the direction of each view and the place from which it was taken. A geologist may be able to deduce from photographs and specimens the nature and age of the rocks and to distinguish groups and structures.

OUTFIT

The essentials are: Hammer, chisel, haversack, collecting bags, clinometer, compass, pocket knife, lens, notebook, and hard pencil. It is difficult to dispense with newspaper for packing. Camera, field glasses, aneroid barometer, foot rule, and similar equipment will be available for general purposes. Some means of labelling specimens must be available (see below under collecting bags, p. 294).

The following may be useful: Sledge-hammer, pickaxe, crowbar, blowpipe equipment, magnet, Walker balance, "spot test" and similar sets, small set of chemical reagents including hydrochloric acid, small quantity of materials for collecting fragile specimens and for taking impressions, prospector's pan (for precious or heavy minerals, but a frying-pan will serve), hand auger or drill for shallow borings.

If bulk and weight are of any importance it is strongly recommended that only the essentials in the first list should be taken, and the following notes are confined to them. Levels, plane-table, and other surveyor's equipment, may be needed for geological work, but will not be discussed in detail here.

Geologist's hammers and similar field equipment are sold by reputable firms such as Gregory, Bottley and Co., 30, Church Street, Chelsea, S.W.3; G. Buck, Goodge Street, London, W.1. They should be of square section tapering to a chisel face at one end. They may usually be obtained with the help of any department of geology or mining: other hammers should be avoided, including local smiths' efforts, as they will probably break or splinter. Those obtained through reliable sources will probably be correctly hafted and of suitably soft temper. For the day's work a hammer of about $\frac{3}{4}$–$1\frac{1}{4}$ lb. and another of about 6 oz. for trimming will usually serve. Spare handles and wedges may be taken, but the fixing of new handles in the field may be a failure. At least two spares of each weight should be taken in reserve for any protracted journey. The handles should be marked off in inches by notching to facilitate quick measurements of thicknesses of strata, seams, etc.

Chisels and centre punches for splitting slates and shales and for extracting fossils, crystals, etc., should be of the best cold steel, weight 2 to 8 oz. Carry with a small bar magnet in leather case.

Haversack should be exceptionally strong, with leather bottom, two large divisions, and pocket for maps and sketch-books. For climbing, a pack or rucksack with leather bottom.

Collecting bags: recommend cotton or linen bags with tape sewn on outside for tying; about 10×6 inches. Writing on the outside in indelible pencil not always satisfactory: recommend only a number outside, best heavily stamped beforehand; enter this number in field notebook when the bag is filled, with date, time, place, nature of specimen, exact position from which it was collected, and anything that will help to recall the circumstances after months or years. Put in the bag a duplicate of the record folded small and tie with extra wrapping paper if available low down to keep the contents from rolling about. The most permanent method of labelling is to *paint* the number on each specimen, at the end of the day's work. If more than one specimen has to be put in a bag wrap each in paper, or grass, with its own label. The collection then retains its identity and value even if a field notebook is lost. Usually about 300 bags suffice for a few months, since specimens may be repacked in paper, with their labels, and stored in empty food or supply boxes or tins (*e.g.* 4-gallon petrol tins): pack solid, so that they cannot shake loose. A loosely packed collection whether in bags or boxes or tins will be entirely

ruined in a few miles of carriage. Protect bags and packages from damp, rats, white ants, etc.

Clinometer: A pendulum clinometer is usual, but an Abney level is good for all geological purposes, and will probably be in the survey equipment. J. M. Wordie recommends a folding 2-foot rule with two levels and a graduated arc at the hinge. Dips must be determined at right angles to the strike of the beds (true dip).

Compass: The Service pattern prismatic Mark VII meets all needs: oil-filled compasses become useless or sticky if the glass is broken. The usual precautions in the use of a compass must be observed. The Bagnold sun compass with "pistol" holder may be employed for distant scarps, direction of dip slopes, etc. Dips seen on the sides of distant hills are rarely correct (apparent dip) and true dip must be obtained by direct measurement or by resolving several observed apparent dips.

Clinometer and Compass in various combinations are on the market (as supplied by Cooke, Troughton and Simms, 15, Broadway, London, S.W.1), and one may be carried, but if lost or damaged the two most important instruments are involved in a single accident. Take separate instruments also.

Pocket-knife: A good steel blade tests the relative hardness of rocks and minerals, useful for identification. The usual scale of hardness is: 1 Talc; 2 Rock-salt or gypsum; 3 Calcite; 4 Fluor-spar; 5 Apatite; 6 Orthoclase; 7 Quartz; 8 Topaz; 9 Corundum; 10 Diamond. The average knife blade is softer than quartz and harder than apatite.

Lens: Some prefer the three-lens type, but grit between them ruins them. On the whole a single-barrel lens in a metal carrier is best, magnification a matter of choice. Attach the lens to a cord and secure to pouch or pocket.

Notebook: recommend a "day book" of the self-opening type, as sold by T. J. and J. Smith, c/o Stationers Hall, London, called the "Automatic Self Registering Pocket Notebook." The pencil is firmly clipped at the page in use, the pages do not flutter or tear out in a high wind, the paper is strong and well ruled. In addition a very strongly bound diary, loose-leaf or otherwise, which may contain squared paper as desired, about 6×4 inches, should be made up every evening without fail and all entries of the day book copied into it, including bag-lists, measured sections, records of photographs,

and every observation; daily comment on progress after the entries, not mingled. This is laborious, but the whole work is ruined by loss of a notebook. Carry the day book in a buttoned pocket, the diary separately, if possible locked with other important papers. Where climate will allow, there is much to recommend keeping the diary in ink: metal-sheathed ink bottles will stand years of work. Elsewhere use hard pencil, not indelible, which runs when wet.

If the above methods of labelling and note-taking are used, either the collection, the day book, or the diary will enable a good account to be made on return if the other two are destroyed or lost.

Camera: accurate focussing at a few feet is sometimes desirable and a ground-glass screen helpful; perhaps include one camera of film-pack type, probably of quarter-plate size. For general purposes a roll-film camera.

Field Glasses: first-class glasses, preferably with graticules for measuring angular subtensions, are indispensable. Some travellers are satisfied with a pocket monocular; others prefer the wider field and higher magnification of a good light prismatic binocular, such as Barr and Stroud's "sevens" or Zeiss "eights." Large and heavy glasses are a nuisance.

Aneroid Barometer chosen for type of work and maximum altitudes expected: not to be used for measuring sections (unless on a mountain or cliff). It provides a rough check on other methods, and gives differences of level to *c.* 50 ft. Larger instruments accurate to a few feet cannot reasonably be carried on belt or in haversack, and their purpose is in any event served by level or tape.

Method of carrying outfit: In most climates wear a strong leather belt to carry in leather cases: the field glasses, compass, clinometer, aneroid, small pouch for lens with lanyard, spare pencil, watch, and other things, *e.g.* whistle. Some carry the hammer in a leather sheath and pouch with small chisels, etc., on the belt, others carry them in their haversack, more convenient. Notebook should be in a buttoned pocket of the shirt (preferably), not in a garment that may be taken off frequently and laid down, given to a servant to carry, or packed on a vehicle or animal: the book is sure to fall out. Equipment on a belt is handy, easy to wear and quickly thrown off at a resting place: if the belt supports one's trousers or shorts it will not be forgotten on continuing the march. Avoid cross straps over the chest. A light camera and tripod can easily be taken on a belt; but a loaded

haversack drags and is better carried over one shoulder or the load transferred to a pack or rucksack between the shoulders. For reconnaissances on ski, sledging, etc., a Sam Browne belt with two cross straps (crossing only between the shoulder blades) carries a full load better than any other equipment. In a hot climate a simple belt with haversack carried separately is less oppressive.

COLLECTIONS

Difficulties of transport usually limit bulk and weight, and local population often oppose collecting and observation. Good selection of specimens is imperative.

Hand specimens: Large blocks are not necessary: carefully selected pieces should show all that is required within $3 \times 2 \times 1$ inch. Fix a standard size at the outset, and reduce specimens to it in the field: shapeless lumps of rock picked up at random look slovenly and usually fail to show the dominant characters. Practise with a trimming hammer to prepare specimens of one size, fit for exhibition. Careful selection of rock to be reduced to a hand specimen impels search for fresh unweathered material; rotten rock is useless for most purposes. Rocks are sometimes weathered to a depth of many feet. *Specimens must be taken from fresh rocks in place, not from loose blocks.* Put a few fresh chips detached in shaping the specimen in the bag with it: they serve for preparing microscope slides, crushing for mineral analyses, determining specific gravity, without interfering with the hand specimen chosen to show only the larger characters. Any piece of the rock is better than none, but hand specimens must be made in the field or not at all. Unweathered rock in place may often be readily collected from rocky river beds and freshly glaciated surfaces.

Loose materials: Gravels, erratic débris from glaciers or moraines or icebergs, coral or shell sand, marine or river sands believed to contain mineral wealth or for heavy mineral analysis, desert sand for grain analysis, clays, glacier or river mud and silt, blown dust, lateritic and other superficial materials, cotton and other soils, should always be collected. Half a bag full, tightly tied, will usually suffice; but well-cleaned tins with tight lids serve excellently. Form also such collections from stratified deposits of all ages; collect soil samples in continuous series from surface to fresh rock and label in proper order, with a sketch to show range of each bag in vertical section.

These are better than nothing, but soil science is progressing rapidly and its standard soil *monoliths*, with their iron casings, demand special facilities and unlimited time. Enquire of the agricultural survey of the country or from institutions such as that of Soil Science at Oxford.

MINERALS AND PRECIOUS METALS

Collecting falls into two classes: the removal of crystals, show specimens, etc., and the sampling of deposits and ore bodies possibly of economic importance. Both demand a prospector's experience and knowledge; the following notes may enable the amateur to do all that can be expected.

In cold and in dry climates weathering will detach exposed minerals and crystals, best collected where they fall. Elsewhere chemical changes may ruin all but resistant substances like quartz which, however pretty, is not worth much attention. Resistant idiomorphic, *i.e.* more or less perfect, crystals in easily decomposed rock may sometimes be washed out of residue: *e.g.* diamonds, topaz, apatite, etc. The contents of drusy cavities, nests of crystals, etc., usually best obtained by working on the surrounding rock with centre punch and chisel: direct attack usually ruins them. Very large porphyritic crystal (phenocrysts) or free-growing crystals cannot be collected: they can be photographed with a scale beside them, and, if their composition is unfamiliar or potentially of value, a small piece with cleavage fractures will serve as well as a large fragment (*cf.* large felspars, tourmalines, spodumene, micas, etc.). Most crystals or minerals are mixed with other substances, which however uninteresting they appear, should invariably be collected. Minerals for show should be carried in boxes or tins with plenty of packing (paper, grass, even sand or clay), not in bags. Learn in advance, and be familiar with, the appearance of gems (diamond, topaz, sapphire, etc.) when mixed with alluvial gravel or sand.

Generally precious metals are found in veins, lodes, major ore-bodies, disseminations: they are commonly found, derived from one of these sources, in alluvial deposits (gold, tin, etc.), as are precious stones and crystals. Veins and lodes, where they outcrop are commonly "leached" by weathering agents; staining by iron, copper, and other salts is often obvious, and the valuable contents may be im-

mensely concentrated in "gossan," or superficial, more or less insoluble, residue produced by weathering. This is usually the source tapped by native workers, but it will not normally support commercial enterprise. Therefore collect specimens oneself, place little reliance on specimens shown, but make every effort to obtain specimens in their natural state, still mixed with valueless substances from below the superficial concentration.

Many valuable ores, rare earths, etc., look dull or uninteresting, and their use may be locally unknown: skill is needed to identify them, but it is a good rule to collect from vein fillings, masses of rock, deposits or alluvial accumulations that seem in any way unusual. The elements of panning can be learned fairly easily, its full use only by long experience. Some ores, *e.g.* gold, copper, silver, occur finely disseminated throughout a mass of rock, especially igneous rocks and others adjacent to them, though the yield per ton of rock is very small: such substances may advertise their presence along joints, in drusy cavities, or in the gossan (by staining or natural concentrates), or in weathered residues which may be panned. Pyrites has often been mistaken for gold, although its crystal form is usually clear; but valuable ores may occur as a constituent (gold, silver, arsenic, etc.), and representative specimens are worth collecting. Visible gold, the native element, malleable to the knife blade, is a discovery of undoubted value, and probably gold invisible is then also present in workable quantities. Take samples of major ore bodies from the surface downward as far as possible and across the full width and length of the body. Metalliferous veins and bodies may be "cut out" by faults or change of country rock, but may recur at no great distance: seek carefully. The technique of full sampling an intricate ore association demands high training: the traveller can hope only to prove the presence and approximate extent of valuable ore. If his samples are attractive to commerce the further stages will pass from his hands into those of the skilled prospector, geologist, mining engineer. He cannot hope to make a fortune by such discovery: he can collect and observe intelligently, and in many countries it costs little to stake a claim: his troubles will begin when he returns to civilization. If specially interested in minerals consult 'Field Tests for Minerals' by E. H. Davison (London, Chapman and Hall, 1937, 7*s.* 6*d.*) and take the suggested equipment.

COAL AND IRON

Most of the above applies also to bedded deposits of coal and iron, and other minerals. The nature and thickness of overburden are vital; many valuable seams are rendered uneconomic by overburden and structure. In general the higher the specific gravity of an iron ore the greater the content of iron, but impurities may hinder smelting. A good bituminous coal should burn fairly freely in a pile and leave little ash, which should be grey or white; red ash means iron, probably pyrites, an unwelcome impurity. Anthracite coals will not burn readily in the open without considerable draught ; recognize by their hardness and bright surfaces; they are valuable for certain limited purposes. Brown coals and hard peaty seams, light in weight, often full of impurities, are of secondary value. Ascertain the thickness of seams and test their quality throughout. Ascertain whether coal and iron occur in the same neighbourhood, whether other substances, *e.g.* limestone, for smelting, are available near by, with plentiful water, and other fuel if coal is absent. Easy transport from the area, preferably by water, is essential.

MINES

A traveller may be invited to visit a remote mine and encouraged to take a financial interest in it; he can only blame himself if he gets his fingers burned. To what is said above add the following:

Never pay much attention to the parts of the mine shown you; they are sure to be satisfactory. Spend as much time as you can in those not brought to your notice. Collect specimens yourself and do not let them out of your sight in the mine or on the premises (*e.g.* when changing from mine clothes to your own); it is easy for them to be lost, changed, or enriched. If shown a trial bore producing high values, try to return to it later in the day and ask for samples to be taken from it then, under your personal observation. Because you are travelling you may have "Press value": never sign a paper or express views about the mine; you may be quoted as a "famous explorer" and authority on the mine before you get home. It may be cheaper to employ a reliable man to visit the mine for you than to trust your own impressions: the mine staff are optimists and firm believers in its merits; their enthusiasm is as infectious as it may be costly. Any report on mine or claim should include power and

labour resources, communications, laws, customs, and security of the country; local conditions may render a claim valueless.

IGNEOUS AND METAMORPHIC ROCKS

Collecting from igneous intrusions, whether major exposures of deep-seated rocks like granite, syenite, diorite, gabbro, or dykes, sills or volcanic intrusions and surface products, should aim primarily at obtaining fresh specimens of the main rock type, *i.e.* at fair sampling. If no time is available for detailed collection at least the general type of rock constituting the main mass must be obtained. "It so often happens that only special varieties of a large rock mass are collected because the traveller gets used to the main rock and postpones collecting it until too late. A single rock type extending over many square miles should be collected at several points. The general tendency is to collect only special varieties of it" (L. R. Wager). Close inspection will usually show that the igneous rock varies laterally and vertically in composition, or size of crystal, or both. Observe and collect included fragments of other rocks and segregation patches; distinguished by their labels from specimens of the main mass. Variations are especially noticeable near the contact with sedimentary rocks or with other igneous masses. Collect to secure in regular sequence a record of the changes. Labels must be very explicit. Apply same routine to collecting from veins, pegmatites, etc., which penetrate igneous or other rocks. Collect with the hand specimens small chips for analysis.

With metamorphic rocks resulting either from contact with hot rocks or solutions and gases or from dynamic forces, it is supremely important to collect systematically across and along them, for changes in mineral composition. Thus a shale may be traced through slates and phyllites to highly crystalline schists, the original form of which would be hard to determine. Similarly coarse gneisses should be traced, where possible, into less altered forms for indication of their origin. Note the trend, strike, and dip of metamorphosed rocks, with structure, folding, faulting, etc. An apparently inextricable mass of highly altered rocks may be deciphered from extensive collection and good notes.

SEDIMENTARY ROCKS AND FOSSILS

In the simplest circumstances it may be necessary only to collect fossil shells from a single exposure: they will be useless if merely

dropped into a bag or tin; if several are to be carried in the same container they must be kept from rubbing against one another. In unknown country fossils are always worth careful collecting, but should be taken fresh from the rock; weathered and worn casts may be unidentifiable: on the other hand weathering alone reveals fossils in some rocks that, on fresh surfaces, appear barren. Collecting should be complete; include all signs of organic remains in a sediment, not only the largest or most attractive. Minute organisms like foraminifera may be more useful than large molluscs. Collect fossils from bed to bed in stratigraphical order, and pack each assemblage separately; haphazard picking up without reference to the order of beds destroys most of its value. Make a sketch and measured section of the beds and indicate the fossiliferous beds by the same symbols as are used on the labels: unfossiliferous strata, presence of boulders, striated or otherwise, pebble beds or other changes or breaks in sedimentation should be carefully recorded. If possible trace the beds laterally to see if they remain constant or change their dip, strike, thickness, lithological character, etc. Massive limestones and some other rocks sometimes appear to be unfossiliferous, but may contain minute carbonaceous remains, spores, seeds, pollen, or graptolites and other delicate organisms which may be revealed in the laboratory on treating the rock chemically or reducing it to thin slices. Shales and slaty beds, apparently barren, may reveal graptolites, trilobites, shells, etc., when the bedding planes are separated by tapping or by inserting a chisel or knife blade. In general it is better to carry out a very thorough examination before declaring a sediment to be unfossiliferous, and even so, specimens should be collected. In traversing a country of sedimentary rocks it is often a simple matter to prepare a valuable geological map simply by recording order of superposition of beds, constantly recording dip, strike, thickness, variations of bedding and by measuring good sections, where they occur: it may not be necessary to leave the line of route to do this work. Note traces of very fine deposits which may have accumulated in deep water.

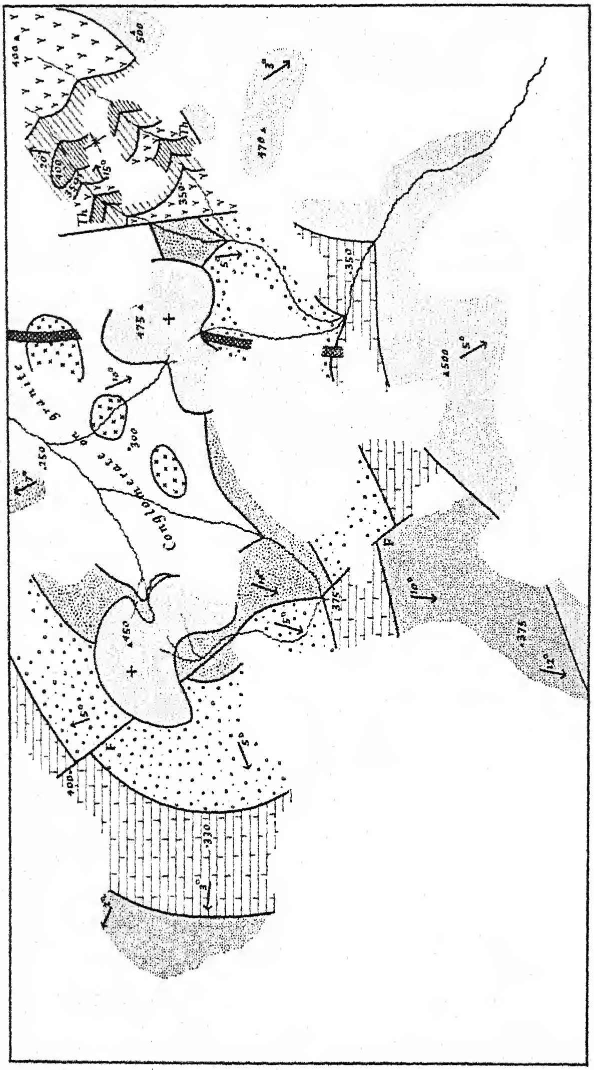
If large skeletal remains are found it is difficult to do much unless the expedition has started out with proper equipment. Such remains are bulky, heavy, or extremely delicate, and often difficult to extract without destruction. Unless the traveller has had some such discovery in mind and has come prepared he will probably do well to

take close-up photographs (with scale) of carefully uncovered specimens and to bring away only specimens that are easily within the capacity of his transport. Skulls are most useful, or, failing them, teeth, vertebrae, or complete limb bones; bones with broken ends are of little use. If the discovery is important it is probable that a properly equipped expedition will visit the spot: good photographs and specimens in the order just given will be of most use to the experts. Material once uncovered and left in place is usually destroyed by inquisitive local people. Travellers wishing to undertake serious work should consult the British Museum (Natural History) or a similar institution before they leave.

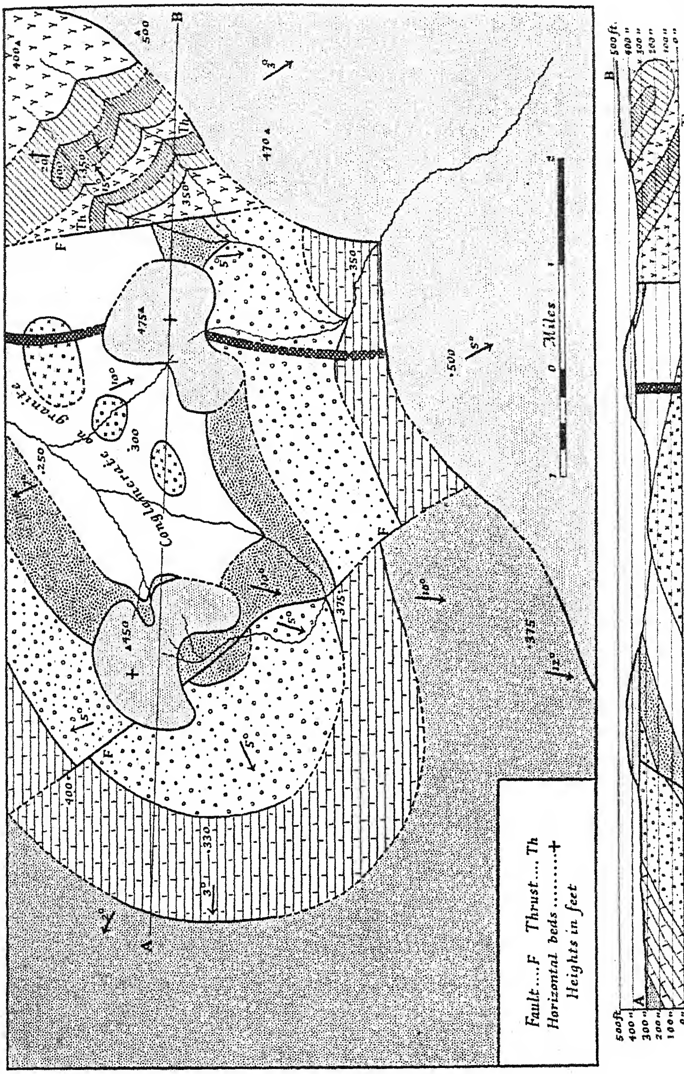
Plant impressions or remains are often difficult to collect. If impossible to remove or transport safely they may be photographed (as large scale as possible, and scale recorded), critical details sketched, and impressions may be taken by the same means as are employed by archaeologists for copying inscriptions. Even so, it is better also to attempt to bring representative, if fragmentary, remains. Fragments of bark, wood, and especially seeds, leaves, impressions of flowers, beds believed to contain seeds or pollen, may be of critical value. There is little point in loading the expedition with cumbrous masses of fossil wood, which may be unidentifiable, and silicified tree trunks are by no means rare. Do not ruin an exposure by battering at it with a hammer in an attempt to bring home a unique specimen, if there is any prospect of a further visit with proper appliances either by yourself or by a qualified geologist.

OBSERVATION AND GEOLOGICAL MAPPING

Observation is intimately associated with collecting, and hints common to both are included above. Consult the foregoing pages as well as what follows. It is assumed that the traveller has learned the rudiments of geological mapping: as he becomes familiar with the country he will find certain forms of weathering characteristically displayed by certain rocks: some vegetation types are highly selective of soil and rock on which they can, or cannot, grow. By such indications a geologist may at times form a good idea of the composition of neighbouring hills and slopes unvisited, or on which the bare rock is not exposed. He should not trust such "rules of thumb" too far; they should always be confirmed if possible. It is hardly necessary to add that colour in a rock is highly deceptive, and, with mineral com-



Geology observed and plotted in the field.
Deduced map and section below, by K. S. in collaboration with C. J. Bayzand.


Fault....F Thrust....Th
Horizontal beds........+
Heights in feet
Miles
Conglomerate
granite

position, it gives no indication of age outside the immediate area of work.

MOUNTAINS

A mountain, a range, or a mountainous region, is an elevated area of strong relief; the geologist is concerned with structure rather than altitude, and a traveller should know what he means when he reports the discovery of a mountain or a range. The region may owe its elevation to denudation, to differential movement, or to folding induced by pressure. Thus a broad area may have been elevated to form a high plateau: intense erosion of its perimeter will, in course of time, accentuate the passage from adjoining lowland to plateau, and this fretted edge will eat far back into the plateau itself, deeply trenched by steep valleys. A mountainous wall is then presented to the lowland. A given stratum of rock may be traced from lowland into the cliff, where higher strata rest upon it. If however the rocks as a whole are highly folded, metamorphosed, or mainly igneous, it may be difficult to prove that the so-called mountain is due solely to denudation. In continental regions widespread elevation and erosion may have taken place repeatedly: a series of bold erosion steps or scarps and narrow inner gorges within broader valley sides may be clearly marked. Such changes may reduce an ancient plateau to a fretted network of profound valleys and precipitous "mountains." Similarly, differential erosion of hard and soft rocks will produce strong relief which will be further accentuated by the denudation of bare slopes.

Differential elevation suggests some readjustment of the superficial layers of the earth's crust in the vertical sense. This may cause actual fracture or bending, or both: crystalline rocks are sometimes found to have fractured at depth while a sedimentary covering upon them has proved more flexible, merely bending or warping above the fracture. Remember that movement may have been either upward or downward; a mass may have been forced up or have fallen down; or a region may have been severely fractured and adjacent segments may have been tilted, risen, or fallen with relation to one another. Hence a given stratum will vary in elevation, dip and strike when traced from block to block, or, if folded, pitch and trend will vary also. Further, differential erosion of the broken surfaces will produce a strong topography, recession of scarps will follow, and in course of

time the scarps will no longer mark the positions of the faults (fault scarps) but may be driven back from them for long distances. In such a region, however simply fractured, one may fail to find faults at the base of major cliffs, but find them in the plains beyond them (fault-line scarps). Intrusion of molten rock may accompany movements of this type and lava find its way to the surface along some of the faults. Fault-block mountains, horsts, rifts, are among the varied structures which, with some reservations, fall into the same wide group of movements.

True folding of rocks implies some reduction of the area available to them: their volume must be accommodated partly by vertical adjustments, *i.e.* by arching, folding, piling up, or by forcing down a part of their mass and loading upon it.

The traveller should have no great difficulty in recording simple folds: he should devote himself to mapping and recording along his route, and as far off it as he can go, dips, strikes, order of beds, and trend of folds. The routine record of dips and strikes along lines of traverse will usually produce a map from which structures can be deduced which cannot be seen on the grand scale in the field. More often than not folds and faults cannot be seen in the field, they may be proved conclusively by plotting sufficient dips and strikes. On the whole the noting of variation of strike is much more important than observing a change in the angle of dip. Any serious disruption, local overfolding, overthrusting, or faulting, should receive special attention and fractures should be traced, if possible, both horizontally and vertically. Look out for signs of repeated faulting, overthrusting, or reversed faulting: major thrust planes may be observed, but should not be too readily accepted. Recumbent overfolds, thrusts and nappe structures may frequently be traced from peak to peak or along mountain valleys: views from high altitudes may materially assist observation from the valleys.

The intelligent traveller can expect to observe and record such structures and indicate thereby to geologists the nature and order of magnitude of folding in unexplored territory. If the mountain building movements have been as severe as here described he can hope to do little more; long detailed topographical and geological surveys necessary will require expert knowledge. He can however look for evidence of age of the disturbances, recurrence (since few mountains have resulted from one period of upheaval), and for signs

of metamorphism and major intrusion or igneous rocks. He may determine the youngest bed that has been folded, if possible by finding fossils, and he may find that yet younger beds rest unfolded, *i.e.* unconformably, on the disturbed rocks: fix if possible by these means the age of the folding. The proof of unconformities between beds, whether folded or not, is of the highest importance. If the strikes of the two series are dissimilar they will profoundly effect their distribution in a region, and will be shown on the geological map. Look for pebbles of one set of rocks incorporated in another, indicating periods of upheaval and denudation and perhaps further disturbance. Trace sediments towards the regions of most intense pressure and observe signs of metamorphism (passage of clays and shales to slates and schists, limestones to marbles, etc.): collecting along such outcrops is invaluable. If rocks are metamorphosed search to find whether the change has been due to pressure or intrusion of igneous rocks: if the latter, observe the extent of intrusion and the behaviour of sills and dykes. Intrusion may have accompanied some phases of folding and thrusting but not others. Observe the relation of gneisses to sediments and intrusive masses. Collect specimens at short intervals in regions of contact metamorphism.

On high peaks see if there is any concordance of altitude and search for signs of a former plateau-level, now much dissected: such planation may indicate that the folding and fracture is much older than it appears. Folds and fractures of all ages look much the same: their age must be proved, it cannot be assumed.

In the inner parts of an intensely compressed region the traveller will be overwhelmed with the intricacies: but if he will record faithfully what he has seen to the point at which he is bewildered he will probably have done the greatest service to geology. How true this is will be seen by reading books like Collet's 'Structure of the Alps,' or Bailey's 'Tectonic Essays,' or, better still, by taking those or similar books first to the Jura and then into the French or Swiss Alps.

VOLCANOES AND VOLCANIC ROCKS

The recording of undiscovered volcanic fields is within the power of any traveller. Major volcanoes he cannot fail to observe, but he should seek for signs of their age: he may find lavas or other ejected material interbedded with soils or deposits containing plants, shells or other organic remains. Seek signs of former glaciation on high

volcanoes. Observe the condition of craters, whether denuded, filled with water or rubble, evidently of great age, or steep sided, bare, containing unweathered lava, hot springs and pools, with gas discharges or steam.

Lesser craters may be found in plains, and intermediate forms between them and true cones. Many circular holes may have resulted from single explosions in places remote from known volcanic activity (*cf. Quarterly Journal Geological Society*, 91 (1935) 358). Search for ejected blocks, and collect specimens, since they indicate the rocks present at depth: determine the age of small lava flows with relation to the strata on, or between which, they lie; and distinguish from sills, the rocks above which, if still present, will show some signs of burning. Look for denuded necks or pillars of consolidated lava and broken blocks of country rock. Record native reports of hot springs, gaseous discharges, disappearance of crater-lakes, or obscure and terrifying noises.

METEOR-CRATERS

See the *Geographical Journal* (*e.g.* 81.227 March 1933) for craters evidently not volcanic. Craters without any sign of lava with rims of ejected material, may be due to impact of a large meteorite. Search the crater and the surroundings for fragments of metallic or extraneous stony material. If no foreign object can be found, seek signs of intense pulverization of rocks around and in the crater. Fragments of metallic or stony meteorites and of glass may be found over a wide area (*e.g.* tectites). But do not rashly assume that a crater is meteoritic; it is, in most regions, more likely to be volcanic.

RIVERS

In regions of high relief subject to heavy rainfall, sudden storms, or seasonal melting of snow and ice, severe flooding usually sweeps the valley floors, which may be bare or boulder strewn: measure the profile of the river bed, note flood marks on the side, position and size of waterfalls and rapids, mark steps or breaks in the contour of the valley, measure velocity and volume of water from time to time, and collect pebbles which have come from the upper reaches which you may not be able to visit (thus gaining some idea of their geology). Observe the cross section of the valley; it may indicate one or more periods of downcutting. Observe low cols between valleys and con-

sider whether certain rivers are absurdly small for the size of their valley, while neighbouring rivers are the reverse and actively eroding their beds, *i.e.* captures may have been effected. Examine the courses of rivers with relation to especially resistant rock masses, whether they flow round or across them, along or across faults, folds, etc. Regions of lakes or marsh near the headwaters of a river or between rivers may indicate reversal of drainage.

In broad valleys, lowlands and plains, wherever situated, rivers have an opportunity to sort their load and to deposit what they cannot carry. Study the method by which the river adjusts its load and course. Long banks of material will accumulate after floods and in course of time the river will shift its main course and probably lower it. Terraces of old detritus will thus be formed in step-like array: it does not follow that they are very old, but some may be. Search for remains of ancient man, and of habitation upon them, and for contemporary fossils. A change in the regime of a river may cause it to raise its level and bury its old alluvium again. Take great care in measuring and defining abandoned rock platforms or terraces and the deposits upon them. Watch for non-fluviatile deposits of dust, loess, soil, etc., upon old alluvial flats, and for morainic material which indicates the advance of some glacier. The study of river deposits has become a science of its own; support observations by careful measurements, photographs, and samples, fossils, and human implements. River banks and rapids, like sea cliffs, provide valuable natural sections of the solid rocks of a region, especially in dense forest and in wide alluvial plains where the solid rock rarely appears on the surface.

GLACIAL ACTION

In the collecting grounds, whatever their magnitude, the traveller will probably find that the snow and ice, if motionless, is preserving the underlying surfaces without change from their pre-glacial form. Surfaces exposed to rigorous frost action and thawing diurnally or seasonally are found to be shattered: screes at the bottom of exposed cliffs vary in size according to the nature of the rock, slope, surface area, and time of exposure, aspect with relation to sun and wind, and so on. Much useful observation remains to be made on the questions of protection by ice, frost-shattering, and on corries.

It is generally agreed that, in given circumstances, moving glacier ice

has great power of erosion: on the other hand it may move fairly freely without doing great damage, speed and load playing an important rôle. The relative amount of erosion is still debated (*cf.* Presidential Address, *Quarterly Journal Geological Society*, 83, 1932, and *Geogr. Journ.*, 80 (1932) 462; 88 (1936) 263): the traveller can be of most use by recording faithfully what he sees, without bias. In the lower levels attained by glaciers, or formerly attained, there is accumulation of transported débris, either on land, in lakes, or in deep water, with calving of icebergs, loaded with mud and débris; collect samples when possible.

Most readers will be familiar with the problems of which hints are given above. Others should read some of W. M. Davis' essays (*e.g.* his paper on North Wales *Quarterly Journal Geological Society*, 1909); H. W. Ahlmann's long series of papers in the *Geografiska Annaler* and books such as Hobbs' 'Characteristics of Existing Glaciers'; Wright's 'Quaternary Ice Age'; Wright and Priestley's 'Glaciology.' The *Journal* abounds in useful papers.

Screes much larger than those at present being formed amid peaks and ridges shattered by weathering, probably associated with amphitheatre-like corries or cwms with precipitous sides at valley heads, or cols through the ridges cutting off isolated peaks or mountain groups: these and associated features may indicate fairly recent glaciation of the "corrie stage," and it is worth looking for signs of the abrasive and transporting power of glaciers.

Sometimes open to the air, often revealed by clearing turf or rubble from rock surfaces, are striated surfaces, smoothed, polished, sometimes undercut by more or less parallel scratches and striations; distinguish from polishing due to the abrasive action of grit-laden wind (which lacks fine striation), and from striation produced along faults and thrusts and by the slipping of masses of rock: soft matrix as well as harder elements may then be equally striated.

Main glacier valleys may have a prominent U-section, and be clear of screes and protuberant spurs: unglaciated tributary valleys may lack this section and lesser valleys join the trough high on its flanks, *i.e.* hanging valleys. There is much discussion as to the relations of the two types. There may be a succession of lakes from the corries down the valleys, and on the upland surfaces, they may be true rock basins, or partly or entirely held by moraines. Steeper gradients, probably well smoothed, will be found at the points of

junction of glaciers than occur in either valley near by. Perched blocks may remain high on valley sides and uplands and may be erratic, *i.e.* derived from outside the normal river basin. Erratics may survive when all other signs of glaciation have disappeared. Roches moutonnées may be of almost any size. Nunataks of an old ice-cap may be smoothed on their lower flanks and the upper part frost shattered.

Valleys and lowlands may be variably covered with a carpet of boulder clay, boulder and block moraines, old terminal, lateral and surface moraines. Terminal moraines may be crescentic, with an outwash apron of cobbles, pebbles, sand, and silt outside them and a monotonous drumlin belt (often studded with lakes) within the crescent and in the lower parts of valleys. These may serve as signs of lower glaciation limit of former times, especially of importance in low latitudes. Esker-ridges of sand and gravel may trail across the country. Old deposits of lakes, etc., may show banded arrangement due to heavier run-off and deposition in summer than in winter (varve clays).

These are some of the indications of glaciation, or former glaciation: if a reasonable number of them cannot be observed it is unsound to state that the region has been glaciated.

LAKES AND TARNS

In glaciated regions tarns are abundant: some certainly occupy hollows scooped out of the rock by moving ice, *i.e.* they occupy rock basins: many which appear to do so are in fact retained by moraines on one side or more. Investigate this point in recording any newly discovered tarns, either in corries, valleys, or uplands. Lakes may be held in old volcanic craters, or impounded by earth movements reversing the drainage, or by subsidence, or other causes. Most of the major lakes in glaciated regions, especially in the lower parts of valleys, are retained by moraines, landslides or alluvial fans: they may be of great depth and soundings will probably reveal surprising irregularities of their floors. Where possible, take soundings, temperatures of the water at various depths, and samples of the water in lakes of whatever origin. Inspect the margins of lakes for signs of former higher levels, overflow channels. Measure and examine old beaches and lacustrine deposits. Shells, etc., should be collected. If the lake has varied in level an immensely complicated series of

beaches and deposits will have been formed, confused by the varying behaviour of rivers entering the basin, building successive deltas and eroding new channels. Do not assume that variation of level implies variation of rainfall or evaporation. There may be evidence of tectonic changes, capture of rivers, opening and silting of outflow channels, and so on. If the traveller is only passing he will do well to record plain observations and no more: otherwise he must settle down to a prolonged investigation without preconceived notions.

DESERTS

Much work has been done in the great deserts and their investigation is slowly passing from the exploratory stage. The motor car and aeroplane are opening up regions inaccessible to pack animals. Nevertheless few of the outstanding problems are yet solved. Realize that in absolute desert the prevailing wind is the dominant feature of erosion and deposition, and all features may be so aligned or slowly moulded to it: over a prolonged period the direction of that wind may have varied, and older features may show this change. But many of the arid regions are not absolute desert, and, especially in North America, occasional heavy rain on bare surfaces plays a dominant part; wind is secondary or negligible: the topography is then largely governed by run-off slopes with veneers of gravel and by retreating scarps (the pediments of American geologists). Detailed surveys and reports on the nature of all surfaces are welcome. Despite the work already done, observations on wind-facetted stones seen *in situ* and on the vermiform markings and polish upon them, are still needed. Observations on sand dunes on the lines suggested by Bagnold (*Geogr. Jour.*, 85.342), or on other original lines, are particularly desired from regions of true desert. Study methods beforehand.

"Dunes are mobile heaps of sand whose existence is independent of either ground form or fixed wind obstruction. They appear to retain both their shape and identity indefinitely, and so to have an interesting life of their own. Contrary to common notions, there is no evolutionary connection between a sand ripple and a dune. The former is never more than a few inches in size and is merely a surface phenomenon, whereas it is doubtful if the latter is ever smaller than 20 feet across. There appears to be no upper limit to the size of a dune.

The individual *seif* dune has a form very like that of a sand-drift behind a rock, as just described. Its length or axis lies in the direction of the prevailing

wind, and its long crest is a knife-edge ridge, one side of which is rounded and the other falls abruptly as a collapsing front. As with the sand-drift therefore the collapsing front faces a direction at right angles to the line of the dune and to the prevailing wind. The side on which the front occurs depends on the side to which the wind has temporarily veered out of its prevailing direction. The whole aspect of a *seif* dune may therefore change within a few days.

The individual *barchan* may be described roughly as a circular dome of sand, from the leeward side of which a big bite has been taken, leaving a collapsing front in the form of a hollow semicircle. The distinguishing feature of the *barchan* is this hollow crescent-shaped front, which faces directly down-wind instead of sideways as in the case of the *seif* (see Fig. 2).

As with the *seif* dunes, *barchans* congregate together. But owing to the transverse nature of the dune, no continuous straight ridge is possible, and a *barchan* line will be broad and ragged in configuration."

Bagnold. Libyan Desert. 82.122.

"1. There are two types of longitudinal dunes or sand-ranges: (*a*) a broad low whaleback composed of an aggregate of grains of all sizes apparently arranged so that practically all interspaces are filled up; and (*b*) a chain of mobile cascading crests of fine grains. These are usually seen riding on the whalebacks. Scattered about, usually on the western side of a range, are isolated pools of liquid sand composed entirely of large grains all of the same gauge. Now a perfect aggregate contains various gauges of grain in quantities which bear a definite relation to one another. It is suggested here that the wind tends to sort out grains to form whalebacks composed of grains in these proportions. An excess of fine grains in any area is swept up into heaps along the top, forming crest chains. An excess of large grains collects in pockets to form liquid pools.

2. Longitudinal dune ranges always shrink away from any rocky or broken ground, and seem to be unable to climb a continuous slope steeper than a certain angle, of the order of 1/100.

3. The prevailing wind as far south as lat. 26° 30′ seems to have taken a turn to the westward during the last half mile or so of dune growth.

4. There is a tendency, after Nubian Sandstone has been reached, for the longitudinal dunes to transform themselves into barchans. It happens in Kharga and in the Sand Sea, and may be due to some grain contamination coming from the sandstone, or to the latter's more broken nature.

5. The presence of quite large stones on the tops and western slopes of the whalebacks is interesting. How did they get there? The sand has not shrunk away from them as would be the case in an ordinary sand-drift."

Bagnold. Libyan Desert. 78.28.

Another problem lies in the deep depressions, hollows, and basins commonly seen in deserts and semi-deserts: in North America and Central Asia many are undoubtedly tectonic; many are deeply filled with terrestrial deposits washed (or in part blown) from higher levels and their origin is less certain. The great depressions of the French

Sahara are commonly supposed to be, in part at least, tectonic. In the Libyan desert on the other part many geologists maintain that there is little reason to suppose that land movement has played much part, and they attribute the depressions to erosion. In these and other arid regions detailed study of the disposition of strata around and in such hollows is much needed.

In the regions already enumerated work has been done on the subterranean water supply: any traveller should consult the apposite official literature and papers in the Society's and other journals. In any unmapped arid region he can do useful work with little previous training if he makes a topographical map and obtains the altitude of water sources, either on the surface or in wells: it may then be possible to predict other sources from his map.

These, then, are some of the problems worthy of attention: it is desirable that an intending traveller in any arid region should inquire from official or other sources what is most needed: in any one of the great continental deserts he may be able to do work of real benefit to mankind.

SINGING SANDS

The phenomenon is widespread, but the theory obscure. Careful observations are much to be desired.

"Providence however placed a large solitary barchan right in our path, so we were able to spend the night (Camp 18) in complete calm between its outstretched horns. This barchan faced 214°. It was 70 feet high and the breadth between the horns measured 220 yards. The bottom 3 feet of the concave cascading slope between the horns gave out a deep booming note when disturbed. A higher note could be got by sweeping the sand up quickly between the hands, and a still higher note by pounding a small quantity in a mug. It appears from this that the volume of sand concerned has some effect on the note produced. Several of the cascading crests of the sand-ranges south-west of Ammonite Hill also gave out this booming if one descended the slope bringing down a quantity of sand." *Bagnold. Libyan Desert.* 78.31.

"It is in such rugged sand-dune regions that singing sands are to be encountered, and here I met the phenomenon. As we moved along a sudden droning noise commenced; a cliff of sand, topographically called 'Khait,' on our right hand, at about 100 yards, was pointed out as the source of it. The hour was 4.15 p.m., and a light northerly wind was blowing from the back of the cliff. The bellowing, for such it is rather than singing, was not unlike the syren of a moderate-sized steamship; of surprising volume, it continued for about two minutes and ended as abruptly as it had begun."

Thomas. Rub' al Khali. 78.215.

"One afternoon as I lay in my tent in the deep sand-bound hollow the slopes around us began to boom. Once before, in 1928, I had heard singing sands near Badr on the Madina road, but from afar. Now we were in the very midst of the concert which had been started off by one of our party walking up the steep sand-slope to keep a look-out. Again and again the phenomenon repeated itself, each bout of the deep droning music lasting about three or four minutes before it petered out. I immediately went up to the summit of the great dune, where a very gentle breeze was blowing from the north, while the sun shone hot and strong upon the sand. I found I could produce the desired effect practically at will by setting large quantities of the sand in motion with my feet. The sliding mass began with a soft grating sound which gradually developed into the deep musical booming as it got lower, and then as gradually the tone softened until it stopped abruptly when the sand ceased to move. On one occasion, having got the music going strongly, I threw myself down the steep slope and almost buried myself in the deep moving sand, which seemed to vibrate and throb under me, but continued singing. I plunged a bottle into the singing mass to collect a genuine sample, and as I withdrew it a long-drawn-out wail as of a trombone followed it. The same thing happened when I tried to disengage my deeply buried knees. I would suggest that this effect is achieved by the formation of a sort of vacuum between the moving mass and the stationary sand over which it passes, the hollow space serving as a sounding-board to convert the initial grating into the final booming. Next day, in the cool of the morning, before we resumed our march, I tried to repeat the experiment, but there was no response whatever, while nearly a month later when we were back at this spot under conditions of cloud and occasional rain, there was no repetition of the concert, which of course my companions attributed quite seriously to the Jinns."

Philby. Rub' al Khali. 81.15.

"Of the sand-dunes which surround the lake, two only are singers, or rather instrumentalists, for the sound is that of a roll of drums, and may be heard by any one who takes the trouble to start it going. We were able to work off some of the energy which we might have wished to direct against our captor by climbing to the summit of the dunes—a most laborious undertaking. Sitting on the crest we would slide down, and after we had gone 50 yards the booming of a great vibration seemed to shake the very hill beneath us and the sound of drums would fill our ears. There have been other lakes than this among the dunes, but the Crescent one alone has the sand-resisting power which prevents it being smothered."

Cable. Dzungaria. 84.22.

SUPERFICIAL ACCUMULATIONS

In nearly all parts of the world certain changes take place on the surface without dominant transport. In high latitudes and at high altitudes soil polygons, etc., are formed; in this frost plays some part. There is a wide international literature upon them and their study involves complex physical and mathematical problems

(*cf. Quarterly Journal Geological Society*, 83 (1928) 163). In temperate to tropical latitudes the problems of soil science are open to investigation. Laterites, cotton soils, red soils, reddening of wind-blown sands, formation of iron, silica, and other pans, and so on (*cf.* Imp. Bureau of Soil Science, *Techn. Comm.* No. 24, 1932, and other reports), demand attention everywhere within the tropics and to some extent in other latitudes. Look out for such accumulations, collect specimens and above all record the circumstances of their occurrence, present rainfall, whether they appear to be still forming or in process of decay, their altitude and disposal on flat land or slopes, near or remote from water. Collect any fossils. If the traveller will take the trouble to consult local or government authorities or experts in his own country he cannot fail to do useful work.

Wind-blown sand, dust, and loess accumulations are to a varying extent imported materials: note and observe their relations to other surfaces or accumulations.

"The shrinkage of the lake may almost be accounted a danger to the surrounding country, for the prevailing south-east wind dries the bare sand of the shore and blows it inland in the form of dunes, which have their origin only 100 yards from the edge of the lake and are now sweeping forward at a rate of something like 50 yards a year." *Fuchs. Lake Rudolf.* 86.117.

"To convey in a few words the extent to which desiccation has proceeded it must be pointed out that twenty-five years ago it was necessary at a point 14 miles south-south-west of Maun to dismantle all wagons travelling to Maun from the south and ferry them over in sections by canoe. To-day there is no water there even at the height of the normal flood. Tsau was then periodically surrounded by water; to-day water has to be dug for to a depth of 18 feet in the bed of the Taoge, and this year's flood stopped 20 miles north of Tsau. In 1920 there were pools of water in the Botletle River at Mopipi, 204 miles south-west of Maun, and the river was running at Rakops, a few miles north-west of Mopipi. But this year and last the flood only went 6 miles beyond Makalamabedi (61 miles from Maun), and at Menakwena (104 miles from Maun) the natives have not seen running water since 1925, and then only because it was an exceptional flood. In a word, the once perennial surface waters have receded some 140 miles in eleven years. The cause of this is, of course, loss of current attributable to raft obstructions of papyrus, etc., Gomoti trees, fish traps, and branch enclosures round cultivated lands."
Rey. Ngamiland. 80.294.

"There are two reasons to account for the number of abandoned cities in the Gobi: one is warfare, and the other is desiccation owing to changes in the watercourses. These latter can be observed even in a very few years, and it may happen that in an incredibly short time even a prosperous city may have

to be abandoned. Sohyen and Pulungchi are now dry, and the large town of Suchow also is threatened by water shortage. Ten years ago there was a swamp in the western quarter, but now not only is the soil quite dry, but there are evidences of the wells failing." *Cable. Dzungaria.* 84.21.

"In a previous paper it was remarked how the great mass of sand that perhaps formed the Taklamakan enabled rivers to wander uncontrolled, and how the rivers themselves were exposed to influences that militated against permanency in their courses. The argument from old sites is far from convincing, and may be most fallacious. Sites are abandoned for many reasons: (1) disease; (2) war or rebellion, of which many examples are found north of the Tien Shan, especially on the main road from Manass to Ili, and where there has been usually no attempt at re-settlement; (3) excess of water, *e.g.* Qaraqum, south of Kurla; (4) salt in the soil; (5) dispersion, failure, or disappearance of the water, more frequently due to artificial causes than to natural; (6) better land available elsewhere; (7) sand; (8) squatting.

This last is particularly prevalent nowadays, as under present regulations a peasant opening new land is given free seed and pays no taxes for three years; and thus there is a regular practice of squatting on land and at the end of every triennial period moving elsewhere. In a land where building costs almost nothing, and land and wood are free, abandoned houses exist everywhere: so much so that it is easier to build a new house than to repair the old. Settlements are moved also because they are inconvenient. For instance, the people moved from old Domoko in the Khotan district about 120 years ago because the present site of new Domoko proved more convenient."

Schomberg. Tarim. 80.133

EARLY MAN

By good fortune one may find skeletal remains of early man: record with minute accuracy the circumstances in which they were found. It will probably be necessary to remove and bring home these remains, but if they are of the highest importance a specially organized expedition may be sent to the site: it is essential that the actual spot should then be recognized from photographs, and probably by the returning traveller himself. Take the most elaborate precautions to this end, but without exciting native interest, which will almost certainly lead to interference in the discoverer's absence. Buried remains alone are likely to be complete skeletons.

The implements of early man are widespread and comparatively common. In country now uninhabitable they are important for that reason. Record exact position and altitude, proximity to high ground, river or other water source past or present. If there is, and always has been, game in the vicinity, though no human occupation at present, there is no first-rate importance in the discovery of human implements, though it is valuable information: this applies

equally in deserts and in, say, circumpolar lands. In regions which have probably been inhabited indefinitely the mere discovery of implements is a matter only of distribution: it is therefore the more important here to find them if possible in stratigraphical order in river gravels, cave deposits, loess, etc., or perhaps in deposits interbedded with glacial débris. Search caves and cave earth for human remains, implements, and contemporary fauna: note relations to sealing bands of stalactite. Search caves and overhanging rocks everywhere for drawings and paintings, which should be photographed and faithfully copied; search and if possible sieve the ground near them for other remains.

COASTS

For mapping the rocks cliffs provide excellent sections. If contemplating other coastal work either by land or sea read some such book as Douglas Johnson's 'Shore lines and Shore line Processes.'

Knowledge of the coast itself, apart from mapping, turns on questions of erosion, elevation, and depression. If the last movement has been one of elevation, or fall of sea-level, old shore lines may be recognizable above the present one: these may be wave-cut benches of the solid rock, or old cliffs, or beach deposits of the former shore. Take great care to prove that the supposed platform is not merely the outcrop of a hard bed of rock, that the area is not swept by storm waves, that the supposed beach is not a storm beach, or, in high latitudes, due to overriding of shore ice. Beach material may be flung far back on to the land and slowly accumulate there, and the marine shells in it are then insufficient evidence of a former land or sea-level. Shells may also be blown far inland or carried by animals or man. The filling of a bay leaves inshore storm beaches which suggest elevation. Caves, not necessarily sea caves, may have beach material flung into them in storms. Therefore caution is necessary before we assume elevation of the land. If, on the other hand, platforms, beaches, and cliffs can be traced above sea-level for long distances their evidence becomes more certain. In regions that have recovered from depression during the Ice Age, or are recovering, it may be possible to trace old shore lines upward from sea-level to considerable altitudes along the coast or inland along a bay. In elevation of this type lagoons may be cut off from the sea and elevated,

and may contain a marine fauna: ice-pressure and storm beaches often play a part in the formation of the lagoons. Their fauna is therefore important and should be collected. Remains of whales, etc., too big to be moved by bears or other animals, or with bones still associated, may be found in the beach deposits.

It is difficult to measure the actual height of a raised beach or platform, which frequently presents a gradual slope to sea-level: subsequent marine erosion may truncate the slope and give a false appearance to the remainder. Use the level to survey sections from the sea to the back of the old cliff or shore line, and mark on it thicknesses of old beach material. This done at all suitable points for the traverse of the coast gives an accurate picture: mere statements of altitudes of raised beaches are frequently inaccurate, biased, and discredited. Record time, date, and state of tide in measurements made from the sea.

Submerged coasts are perhaps more easily recognized by the intricate pattern of the coast, drowned river valleys and estuaries: make soundings of supposedly drowned river valleys to see if the curve of the valley (in the vertical sense) is maintained below sea-level. Even so, there is no evidence of the date of submergence, as there may be fossil evidence of emergence, unless buildings are known to have been submerged or trees stand out of the water (as in some lakes) or peat beds, bogs, etc., can be proved beneath sea-level (the so-called submerged forests). They may be exposed at low spring tides. Ascertain the tidal range and attend to the shore's exposure to or protection from high winds. Note the run of ridges on a shingle spit, whether they are truncated or crossed by others. Beach-drifting by oblique waves should be observed. Marshes may indicate submergence, but they can form behind bars, etc., at constant levels. Shallow borings by auger may settle the point by proving the thickness of the mud. Plant zonation should also be recorded. (*J. A. Steers*)

In regions once glaciated and along coasts known to suffer tectonic disturbance the form of the valley sides and sea floor must be accurately determined: it is improbable that the long and narrow fjords of such regions are due to submergence alone: emergence may in fact be going on, and the form of the coast be due to extraneous causes.

Much has been written about major elevation and depression of

the ocean floors and adjacent land masses, especially in the southern hemisphere. A great deal of this is highly controversial and one may be able to add little except by careful observation and collection, with results which may have unexpected bearings. Observations of the geology, living and extinct fauna and flora of oceanic islands, if not already well known, may be valuable.

CORAL REEFS AND ATOLLS

Their proper study has become highly specialized: study such text-books as Davis' 'Coral Reef Problem,' J. S. Gardiner's 'Coral Reefs and Atolls' (see *Geogr. J.*, 78.460); Darwin's' Voyage of the *Beagle*,' and 'Geological Observations,' are classics.

Useful work includes biological research, sounding outside and among the reefs, or inside the atoll lagoon. One can readily study the landward side of fringing reefs, and the habitats of organisms other than corals. Old reef often occurs above sea-level, and provides detail of the coral and also of the inshore facies. Remember however that these raised reefs may have been attacked by the waves unequally along the coast, and present cliffs of varying height, while elsewhere there are no cliffs. These fragments may therefore give a false appearance of unequal elevation, or tilting. Work on the adjacent coastal plane to correlate river terraces or gravels with raised reefs, but trace deposits in unbroken continuity from one to the other.

J. A. Steers recommends that detail should be obtained by plane-table surveys, to show beach rock, mangrove swamps, shingle ridges, pure sand ridges or cays, and land vegetation. Levels must be referred to low, mean, or high water, and the tidal range fully ascertained. Shallow bores with hand auger through sand, shingle, and muds may produce valuable results; the samples should be carefully preserved.

On reefs of all descriptions storms may pile rubble to considerable heights, or set up strong currents in shallow lagoons; make proper allowance for these actions before assuming change of level.

"The tides of our English coasts have only small diurnal components. The sequence of neaps and springs is however most easily understood as the consequence of M_2 and S_2 passing in and out of phase. But it was the perplexities of the tides in the tropic seas that led to the practical development of tidal theory: and so rapidly did the theory "rationalise" these difficulties that Kelvin, as early as 1870, was able to write of the tides in the Indian Ocean:

'The tides in those seas are commonly designated as "irregular." That

designation results from a confusion of terms, "irregular" being used as if synonymous with complicated. The truth is that the tides on the European coasts of the Atlantic are irregularly simple: those in all other seas are comparatively complicated, but regular and explicable.'

The Low Isles tides, typical of the tropics, show the influence of the diurnal components: these, when they are in phase with one another, have together an amplitude as large as M_2. Under certain phase conditions therefore one of the semi-diurnal tides will be considerably reinforced and the other sensibly masked. This concurrence of events takes place in winter and summer, *i.e.* at the solstices. This is the phenomena of one high tide in the day, described by Cook: the tide of 10 June 1929—in Fig. 2—is characteristic. In the winter (June) the low tide is by day: work is therefore greatly hindered in December on the reefs, because the only low tide is in the middle night watch. Some of our midnight excursions on to the reef flat with lanterns were nevertheless quite amusing; there is something comic about a fish leaning against a rock fast asleep." *Spender. Great Barrier Reef.* 79.206.

[*Note by Editor G.J.*—We must not omit our thanks to the Director of the Liverpool Tidal Institute, who very kindly undertook to compute at his Institute for a modest fee the tidal observations made by the Great Barrier Reef Expedition, and to deduce the constants published above.]

WATER SUPPLY

Water supply may be considered either for the needs of a party on the move, or for the possibility of impounding surface water, or for tapping underground supplies. The first is dealt with elsewhere in this book (pp. 85, 201). The second and third are effectively explained on practical lines by G. W. Grabham, 'Water Supplies in the Anglo-Egyptian Sudan,' 1934, Bulletin No. 2, Sudan Government, London Office, Buckingham Gate, S.W.1; the third is dealt with in many text-books of which 'A Practical Handbook of Water Supply,' by F. Dixey; Murby, London, 1931, is recommended.

A site for a reservoir, dam, or barrage, requires detailed survey by engineers and geologists, but the traveller can do the following preliminary reconnaissance: (1) discover the annual rainfall and above all how it is spread over the year; also obtain estimate of losses by evaporation; (2) get records of annual or exceptional floods; (3) in a river or basin search for a bar of hard rock like granite, gneiss, quartzite, which might afford foundations for a retaining wall; (4) survey the area above the possible height of the work to obtain an estimate of the cubic capacity; (5) observe dip and strike, lithology and jointing of beds; the geology of the whole area must eventually be known in detail; permeable beds dipping under the proposed work, or dipping out of the area, may ruin its water-holding prop-

erties; it is best if beds dip upstream; some limestones are especially unwelcome, being well jointed and soluble; (6) observe all faults and fractures, folds, and disturbances of the rocks which may cause leakage; (7) if water is needed for power, measure difference of altitude of proposed reservoir and power-station, and estimate minimum flow of water: a hydraulic enterprise that cannot work in a dry season or during annual freeze-up is likely to be uneconomical; (8) if water is needed for drinking it must be uncontaminated: a sparsely inhabited district with little game or herds is best; and the rocks must not contain injurious or inconvenient soluble ingredients.

The supply of water from underground sources depends on (1) that proportion of the annual rainfall which is likely to sink into the ground; (2) area of the catchment basin and percentage of that basin which is floored by rocks capable of taking in water; (3) the capacity of those rocks to let water pass, *i.e.* the permeability of the porous beds. Water may be transferred long distances underground, to become available as an artesian source elsewhere, as in desert oases and in wells sunk at predicted sites (Ball, *Geogr. J.*, 70.105).

Of the rainfall part is evaporated or used by plants; part runs off in the natural drainage, and may be impounded; and part is absorbed, and passing underground may be obtained by boring. The relation of surface loss, run-off, and absorption varies enormously; a third to each may be a very rough guide, but in deserts, forests, regions of ill-defined or very rapid drainage, and of impermeable rocks, only an insignificant percentage may be available from any one source, and will vary from year to year.

Impermeable rocks include most igneous and metamorphic rocks (including marble and slate), shale and clay, flint or chert seams, and hard limestone unless jointed. Porosity is the power to take in water, and may be measured by weighing a given cube of a rock dry, then soaking it in water to expel air; then weighing again. Permeability depends on porosity and jointing.

The superficial drift must be examined and mapped; impermeable boulder clay may stop the supply of water to a subjacent permeable and porous bed.

The water table, that is, the position of the surface of underground water, depends on geological structure and conditions, the amount of rainfall and configuration of the surface: there is usually a very big lag between time of maximum rainfall and annual maximum

height of water-table. If the water-table surface coincides with the ground-level springs may be expected in suitable places, as in sandstones and porous limestones: patches of alluvium, sands, gravels, and conglomerates hold water where they lie on impermeable clays: such shallow wells are easily contaminated, and the sides of deep wells, obtaining pure water, must be waterproofed to avoid contamination by surface or shallow water.

In artesian wells the water rises by its own hydrostatic pressure, the point of entry of the water into the solid rock being higher than the site of the well (*e.g.* London basin). The static water-level may be known, but a well drilled to this depth or below it will not give water unless the rocks are suitable.

An inch of rain gives ½ gallon of water per square foot: relatively large supplies may thus be obtained from roofs of buildings, provided they can be stored away from evaporation and contamination.

THE ACCUMULATION OF SNOW AND ICE

Snow and ice accumulate in simple snow slopes, in corries or cirques, on extensive areas of highland ice, and in greatest quantity on relatively smooth ice caps covering islands or reaching continental proportions, as in the Antarctic.

In all save the corrie or cirque the motionless mass seems to protect the pre-glacial topography; exposed peaks (nunatakkr) are shattered and reduced by frost; only along the spillways by which surplus ice escapes from the collecting ground is there marked modification of the subglacial surfaces. The destruction of the back and side-walls of cirques, probably pre-glacial river-heads, has been attributed to plucking action along the bergschrund, but glaciologists have long been dissatisfied with this explanation and the problem has been restated by Odell (*Geogr. J.*, 90 (1937)), and attributed in large measure to freezing and thawing of the wall by percolating melt-water. Further observations on what is actually taking place at the junction of snow, ice, and rock in corries are greatly to be desired.

Snow being crystalline solidifies under the weight of fresh falls to form granular *firn* or *névé*. The change from snow-flake to ice-grain, the enlargement of the latter, and passage from firn to blue ice, involve complex physical problems discussed in the works named in the bibliography below. Simple observations and simple instruments can provide further information for their elucidation.

The lower limit of unconsolidated snow migrates seasonally from higher to lower altitudes, and its altitude should be measured at regular intervals in fixed areas of ice and rock for the whole duration of an expedition. The place of the lower limit of snow is strongly influenced by local conditions, but a general idea of what is happening will be obtained better by sustained observation in defined areas than by sporadic observation over a wide field. Drive sticks or light poles into snow slopes and firn surfaces, and record gain or loss of surface against them from time to time. Moss in North East Land fitted large wooden cross-pieces to the lower ends of stakes to give them bearing surfaces. In summer follow snow retreat to firn line.

To discover the net gain of snow in the collecting ground over a period of years, dig inspection pits in the snow and firn, if possible until hard blue ice is reached. The stratification of the previous years' net gain of snow, compacted into firn-ice, can usually be clearly seen in the sides of the pits, and should be recorded layer by layer (see *Geogr. J.*, 90.219 plate); crusts of ice often separate annual layers, but not always. In the deeper parts compressed layers may be difficult to count. Measure the density of the layers, since recrystallization and pressure reduce their thickness and raise their density. The object of this work is to find the annual net addition of water per unit area in terms of mm. or inches. The downward recrystallization of firn can be studied in these pits; note such things as layers of loose crystals, with the size and shape of angular crystals and rounded firn grains; search also for hollow crystals. During the winter's fresh snow the additional load further compresses the firn, and sudden collapse of certain bands may cause the "icequakes" (*firnstoss*) and strange noises heard in the ice.

"Several times we heard and felt a kind of earthquake: on 2 October 1930 at 01.20 a.m.; on 19 February 1931 at 06.30 p.m.; on 2 April 1931 at 06.55 a.m. (Middle Greenland Time). We called it *Firnstoss* (Firnpush or Firncrash). It consisted of a noise approaching rapidly; then followed a loud crash; and then the noise ran away. Our mercury barometer, which had been hung in a separate ice cave at a depth of 6 to 8 feet, was caught and got nearly broken. The layers were compressed by 1 inch. Later on we found in the shaft some soft layers of snow as far as a depth of 22 feet. But below the firn was quite hard like wood, without soft layers. It seems to me that the soft layers can finally not carry the increasing weight of the topmost layers and are suddenly compressed." *Sorge. Greenland.* 81.340.

Insert thermometers at measured intervals in the sides of the pits

from top to bottom, and take temperatures of the air, surface, snow and firn-layers at regular intervals for as long as possible, to find how air temperatures react on snow, firn, or ice-temperatures. If a pit cannot be dug, make auger holes vertically to measured depths, and lower thermometers to the bottom of each. Moss adds: To keep the thermometer from changing while it is being drawn up, coat the bulb with a thick layer of wax. Candle grease does quite well, and can be moulded by a warm hand to form a cylinder about 2 inches long by half wide. Leave the thermometer in the hole for at least half an hour; the wax will protect it for two or three minutes while it is read. If time is short use less wax, but the reading will be less reliable. This waxed thermometer is just as good as the vacuum thermometer and much less expensive. It may be adapted to other uses.

Sounding firn and ice by seismographs is highly technical, requires delicate apparatus, and much explosive, but gives suggestive results in skilled hands. (See *Geogr. J.*, 81.333 and 87.481.)

Natural sections are often presented by schrunds and crevasses, even high on continental ice-caps; as a rule their lower parts cannot be safely studied, but work as above may sometimes be attempted in the upper. Odell points out that blue banding in the *névé* or ice may be due to foliation following lateral pressure and shear, and not to simple bedding. Search for leaflike crystals growing from the walls (Moss) and for dust, dirt, and stone bands, from which collect samples. Discontinuous mud or dust, either rock-dust or volcanic ash, has probably fallen on the snow or firn and been buried; continuous dirt-bands, perhaps highly tilted, folded, or fractured and displaced, sometimes several close together, usually indicate shearing or thrusting of the lower layers, and may indicate that the glacier zone is near.

Bands of coarse material may indicate engulfed surface moraine, the englacial moraine from a hidden rock-mass, or (if much clay and striated rocks are included) a subglacial moraine either in place or raised by thrusting. Where possible photograph such included material, and note full details of inclination, bearing, thickness, material. These, and as yet unexplained bands, may be seen in floating icebergs.

"Bergs of dark colour, called for convenience black and white bergs, have been observed with some frequency off the mouth of the Weddell Sea. When

opportunity occurred for close examination it was found that these bergs are of two distinct varieties: one of them is the true morainic berg, in which the dark portion is quite black and opaque and consists of mud and stones which are often clearly visible; while in the other variety the dark part proves on closer approach to be translucent and of a very deep green colour, resembling that of some kinds of glass used in bottle making, and mud and stones appear to be absent. We can speak then of black and white bergs falling into two subdivisions, the morainic and the bottle-green bergs. At a distance the two kinds resemble each other very closely, and it has been found that they have some features in common. In both of them as seen by us the dark part is always smoothly rounded by water action, and in both, with few exceptions, the junction between the white and dark parts is a perfectly straight clean-cut plane." *Wordie and Kemp. Antarctic.* 81.428.

Study rotted-out englacial moraines near the margin of an ice-mass (crevasses may serve the purpose) for evidence of thrusting: superficial moraines in such positions may be piled on to the ice-surface from low rock-outcrops by rolling down snow slopes in spring; when the snow has gone the rocks are left as a sinuous moraine subparallel to the ice margin. Blocks so transported often have curved striations caused by spinning as they slide down the snow slopes; glacial striations are normally straight. Surface moraines may be buried by locally excessive ablation: on the other hand, large masses of rock lying on the surface protect from ablation while the neighbouring surfaces are lowered. Rock tables, sometimes of enormous size, are thus supported on narrow plinths which are ultimately destroyed by free circulation of air and the rocks fall on to the general surface.

Radiation gullies are produced in the collecting ground near exposed rock walls on which the sun shines, and in thaw they are filled by torrents or lakes. Similarly radiation from fine dust on the surface frequently causes ablation near them and they sink into the surface with resulting honeycomb structure (cryoconite holes).

Ablation on adjoining sides of crevasses may cause pinnacles; so may the sinking of surface moraines as described above; differential movements may also account for pinnacles on glaciers. Heavy snow may disappear from bare rocks in a few hours by evaporation.

Examine the surface often for ice-layers, waves, and sastrugi, their direction, form, and structure. Moss adds that where moving surface waves are found, often bow-shaped, observe the size and structure of their particles, and if possible their density. Growth of frost crystals on the surface may nourish a glacier or ice-cap. Com-

pare with the deposit on sledges, tents, etc., which may not be similar. In maritime regions condensation on ice is important. (Ahlmann.)

The "balance" of the collecting ground depends on the relation of solid precipitation to loss by evaporation without melting, and by thaw. Glaciers drain off a surplus which can be assessed only when the cross sections and velocities of the glaciers are known, both variable. The meteorological observations required to determine evaporation and thaw can be divided into work that can be done on the move, and work requiring fully equipped ice-cap stations occupied if possible for a full year. The latter are fully described in *Geografiska Annaler*, 1933–36, and in the report of the O.U. Arctic Expedition (*Geogr. J.*, 90. 214). The following paragraphs suggest work with a few fairly simple instruments: the results can be computed on return.

At a base camp leave self-recording instruments, or instruments and observer, to get control readings, continuous or at regular intervals, of temperature, pressure, humidity, radiation, wind force, and direction; also cloud formation and drift of higher cloud. Free or captive balloons are generally best used from such fixed camps.

Compare all instruments before and after all journeys with the set at the base camp, and the whole with standard instruments in a permanent weather station or physical laboratory before and after the expedition. Set up instruments as soon as camp is made. Humidity readings are especially important on the ice at short intervals, but during blizzards are unreliable. The conditions on the ice and at greater altitudes are to be correlated with measures of accumulation, ablation, melting, and evaporation.

The Ablatograph (Devik's type) has a white float resting lightly on the surface; as the float sinks a trace is made on the clock-driven drum, which is mounted on strong supports well above the ice; if not properly supported or too near the surface, the recording gear may sink faster than the float. This method is more sensitive than the simple record of surface-level against a stake. Measure direct radiation from sun and sky by the Robitzsch actinograph, which needs careful handling. Measure humidity by light hair-line hygrometer (Odell), or the ordinary sling type, reasonably accurate. A simple hand anemometer carefully used gives wind velocity near the surface; note direction by compass. Find altitude of camp by boiling point, and by several readings of aneroids checked against the control

later, when pressure and temperature differences can be reduced to sea-level to isolate local from general oscillations.

Measure synchronous temperature, humidity, and wind velocity, also at height, by hoisting instruments on a wireless mast, to find how much turbulence and mixing of warm and chilled, moist and dry air, is causing ablation to vary by conduction and convection.

It is possible to calculate the heat received by the surface; the loss of heat by evaporation; effect of evaporation in increasing humidity of the air, which may lead to re-deposition if the air is saturated, turbulence playing a part; and the heating of sub-surface layers by conduction, insink of thaw water, and rain; or by conduction from lower to winter- or wind-chilled upper layers. The ablatograph shows the actual loss; accumulation on a large scale will be shown by the measuring rod, on a small scale by resetting the ablatograph. The density of the snow, firn, or ice layers being known, and their temperature and conductivity, it is possible to calculate the theoretical surface loss.

Where dark rock is exposed the loss will be correspondingly greater, especially in clear weather, but the measured heat will also increase; similarly surfaces exposed to warm winds will lose more not only from temperature difference but from increased turbulence. Even cold wet winds increase ablation for much the same reason, while in adjacent areas protected from the wind the air may be so saturated that solid deposition and crystallization takes place.

"During my 350-km. sleigh journey across the three glacier caps. a pit about 2 m. in depth was dug at each camping place. Sections of three different types were thus exposed: one belonging to the ablation area, another to the accumulation area, and the third to a transition area between them. The firn-line, or climatological snow-line, which is of such great importance to our knowledge of glaciers, coincides with the boundary between the ablation and the transition areas. Such pits, which are very easy to make, thus rendered it possible to determine the altitude of this line without having to wait until it was revealed by the summer melt of the snow. On the North-East Land glacier-caps it was at altitudes varying from 350 to 550 m. above sea-level.

The total ablation during the whole summer at 1580 m. above sea-level was calculated for normal climatological conditions at 2000 mm. of water. During July and August the ablation amounted to a mean value of 2·3 mm. per hour for days and to 1·8 mm. for nights. The investigations resulted in a first general idea of the connection between the process of ablation and the meteorological elements. Heat convection by the air was found to have approximately twice as much effect on ablation as radiation.

In answer to Dr. Loewe's question about the hoar-frost, I should like to

say that its formation plays an important rôle in the alimentation of glaciers in districts with maritime climates. In Norway I have proved this in the highest part of Jotunheim, and my assistant in 1934, Mr. Olsson, measured very great quantities of hoar-frost on Mount Nordenskiöld in Spitsbergen during the Polar Year 1932–33. Most of the "snow" accumulated on this mountain is not snow fallen but hoar-frost. In districts with continental climates, as for instance Central Greenland, I cannot believe that hoar-frost plays any really great rôle." *Ahlmann. Spitsbergen.* 86.98, 99, 111.

These notes have been read by Professor Hans Ahlmann, Mr. N. E. Odell, and Mr. R. Moss, whose suggestions have been acknowledged in the text.

The following works in English are recommended: Wright and Priestley, 'Glaciology' (for ice-physics, ice-form and classification, especially of the Antarctic), Lauge Koch, *Meddelelser om Grönland*, vol. 65, 1928 (reviewing Wright and Priestley's work in the light of Greenland), G. Seligman, 'Snow Structure and Ski Fields,' 1936 (snow structure especially in the Alps), Ahlmann, Sverdrup and others in *Geografiska Annaler*, 1933–36 (ice of polar and other types, methods of research, especially on the firn surface and in pits), A. R. Glen and others, *Geogr. J.*, 90, 1937 (winter ice-cap station, and methods). The *Geographical Journal* contains much information on most regions above the snow-line; the *Zeitschrift für Gletscherkunde*, *Himalayan Journal*, and journals of mountaineering clubs of the countries to be visited, should be consulted.

MOVEMENT OF GLACIERS. *Revised by Professor Kenneth Mason*

Variation of the position of the snout

The snout of a glacier is that point where the melting caused by the increased temperature of lower altitudes balances the supply of ice from above. Thus any change in the atmospheric conditions at the snout, or in the volume of ice supplied from above, or in the rate of flow of the ice-stream, will affect the position of the snout.

There are four main components of snout variation: secular, periodic, seasonal, and accidental.

Secular changes are very small and can be observed only on those few glaciers where the more violent periodic and accidental components can be ignored. They are due to general changes of climate over long periods of time, and an equal increase or decrease of snowfall or of temperature will affect all glaciers in one region in a similar manner.

Periodic variation of a glacier snout is due to annual changes in the volume of the ice-supply, and sometimes appears to be related to weather cycles. Snout observations may perhaps indicate such periodicity, but there are so many complications of climate that periodicity can be revealed only by long observation. In no circumstances can periodic variation determine the actual epochs of weather cycles, since the slope of the glacier-bed, the ratio of supply area to ablation area, the orientation of the outlet valley, may advance the snout of one glacier while its immediate neighbour is retreating.

During the colder months of the year on most glaciers snow is being supplied almost down to the snout, while there is little ablation, for the sun has little power, and radiation and conduction are negligible. We may thus expect a seasonal advance in winter and a seasonal retreat in summer, particularly in glaciers just within or near the tropics.

Accidental variation on some glaciers may be so violent as to cloak all other components of snout movement. The effect of avalanches is partly periodic and partly seasonal, but may be accidental. A glacier may suddenly overcome some obstacle in its path. An earthquake may cause a considerable accidental advance and a "dead end" may be detached. Such dead ends will be below the normal position of the snout and must gradually melt and disappear. These accidental advances will entirely vitiate all secular, periodic, and seasonal observations.

We believe now that we can define approximately those glaciers in which secular and periodic movements are least likely to be smothered by each other and by other movements. Secular movements probably preponderate, and periodic, seasonal, and accidental movements are probably least effective, in large longitudinal valley glaciers, having a small ratio of supply area to waste area; in glaciers which flow in broad straight valleys with a general east–west direction; where the slope of the glacier-bed is gentle and even; where any tributary glaciers are open, exposed and with gentle even beds, and neither they nor the lower reaches of the main glacier are subject to large avalanches; and where the snout itself is not subject to erosion by its own or another stream.

Marked and fairly regular periodic change may be expected on transverse glaciers with large ratios of supply to waste areas; where the gradient is steep and the outlet narrow; where there are no large

tributary glaciers entering the lower reaches; where the melting area is least affected by variable sun or radiation; and where winter and summer conditions are as nearly uniform as possible. It is therefore important to explore the glacier basin and note the nature of the surrounding hills and the height of the snow-line.

Recent movements of glacier snouts may be noted by the following signs: When the snout is advancing rapidly, a section across it will generally be markedly convex, ice-falls are steep and broken, crevasses vertical and with sharp edges. Old terminal moraines will be disturbed and recent moraines will show cracks, being obviously pushed forward by advancing ice. There is a tendency for the glacier to terminate in a vertical front, but this may be only a normal sign of winter seasonal advance and may indicate no periodic movement. The date of observation is therefore a very important factor. The cross section near the snout and the steepness of the front tells us nothing about secular movement, which is too slow to overcome seasonal effects.

When the snout is retreating it is generally flattened and degenerate, and there may be detached pinnacles stranded below the snout. Such detached pinnacles are not however proof by themselves that the glacier is retreating, as they may have been detached by some accidental cause. Marks of recent extension may be seen both at the end and sides of the glacier near the snout, and terminal moraines below the snout, uncovered by vegetation, are good evidence of recent retreat. An ablation valley near the snout, between the glacier and its enclosing walls, indicating that the glacier no longer fills its former bed, is no certain evidence of recent retreat.

To determine the variations in length of a glacier, mark the position of the snout, so that future travellers can note any change. This can be done very simply by painting signs on rocks, for preference in situ, on both sides of the snout so that the line joining the signs passes near the snout. Measure the distance of this line from the snout. A plane-table sketch on a fairly large scale with contours or form-lines of the snout and its immediate vicinity is of the greatest value, as it records not only the position but also the form of the glacier. The sketch should show the position of the signs marked on the rocks, and the positions from which any photographs have been taken. Such photographs form extremely valuable records for the future. If time is available cut the marks deeply into the rocks with

a chisel. Succeeding travellers should observe with reference to these marks in preference to making new signs, and should repaint them if necessary. Paint the date and time of year at the mark. Marks on boulders, moraine, etc., and cairns erected near the snout are of little value by themselves, as they are liable to be moved or destroyed.

When the glacier has retreated to any considerable extent, careful observations of the form of its bed are of value. How far does the U-shape of the valley continue? Are the rocks rubbed smooth on their leesides? How far down the valley have the cliffs or slopes, or sides of any gorge, been subjected to ice-friction? How far down the valley do moraines exist, and are they covered with vegetation?

Variation in volume of the glacier-ice

To determine the variation in volume, a large-scale plot of pairs of photographs made by some stereo-autograph would be most valuable. Subsequent travellers taking further pairs of photographs would then be able to compare the volumes of ice on the two occasions. Another method, less exact, is to note the highest level of the transverse convexity of the glacier at various points in its course. If the glacier is bounded laterally by rocky walls, paint marks on them, opposite one another. Record the vertical height of the marks above the ice at the sides, and the date of the observation.

Velocity of the ice-stream

Should time and circumstances permit, observations for velocity may be made after Tyndall's method, by planting a line of sticks across the glacier, or by painting marks on boulders, the positions of which relatively to ascertained points on the mountain sides have been accurately fixed. Measure the area of the glacier's basin and the length of its central streamline, also the slope of the glacier above and at the point of measurement. The velocity of the ice is connected both with the volume of the glacier and its bed-slope, besides being considerably affected by temperature. Thus a rise in temperature may even be accompanied by a temporary advance, but in this case a sagging will take place higher in the *névé*, producing a concave cross-section, showing that the advance is not due to increased snow-fall, but to a decrease in the viscosity of the ice.

In a mountain group, observe and collect all data possible for each

glacier, being careful to keep conclusions separate from evidence. It is often extremely difficult to decide whether a glacier is advancing or retreating, especially when the glacier is at its maximum advance or maximum retreat, and just at these times exact observations become most valuable. It is utterly impossible, as has sometimes been done in the past, to generalize in a mountain group from the observations of a few glaciers.

A Society, entitled the "Commission Internationale des Glaciers," was formed to promote the study of glacial movements. Their reports were published in the *Archives des Sciences*, Geneva, the Journal of the Swiss Alpine Club, up to 1905, and from 1906 to 1913 in the *Zeitschrift für Gletscherkunde*, Berlin. A summary of the reports in English appeared throughout these years in the *Journal of Geology*, Washington. The Great War disorganized this society, which has now been reformed, in 1930, as the *Glacier Commission*, which is part of the Hydrology Association of the International Union of Geology and Geophysics. This Commission has elected official reporters for all the important countries which contain glaciers, and it is hoped to publish the results of such reports triennially.

CHAPTER XVII. NATURAL HISTORY

By W. L. Sclater and Colleagues

Any English traveller who wishes to assist zoological research should, before leaving England, pay a visit to the Natural History Museum at South Kensington and consult the authorities there how he may most usefully employ his spare time, and to which branch of the animal kingdom he may most profitably devote special attention. The Natural History Museum has prepared a series of directions which are issued separately or can be had combined in a small pocket volume entitled 'Handbook of Instructions for Collectors,' the last edition of which was issued in 1928, and which every intending traveller should procure. If he proposes to devote himself to collecting mammals or birds, the Museum officials will be glad to arrange for a little practical instruction in skinning, and such lessons will be of far greater use to him than any printed directions.

All collections should be carefully labelled with full details of locality, date, sex, and notes on the colours of the parts which are apt to fade. The locality given should not only include the name of the actual village or settlement, but further details as to its general situation. This is most important, especially in such regions as Africa, where not only do the actual names of places often change owing to the death of the Chiefs, but also stations and settlements of Europeans are frequently abandoned and the names soon disappear from the maps, and are very difficult to locate in after years.

Travellers, especially when remaining in one spot or in one district over a considerable period, have excellent opportunities of observing the habits of the animals in a state of nature. Such observations may be of great value and should be carefully recorded in special notebooks in diary form. Any observations concerning animals which bear upon the relations of species to their conditions of life are worth observing and recording. Records of the various enemies with which they have to contend, the effects of external circumstances: dryness, humidity, heat, cold, elevation, and ecological factors of all sorts, are of great value. Again any observations on migrations of mammals, birds, or insects either regular or seasonal or of unusual or special occurrence.

Questions of food and food supply, of sexual or breeding habits, are of special interest, and any observations or investigation on any of these points are likely to be of considerable value.

In humid tropical countries, where the ubiquitous ants are likely to destroy specimens before they are ready to be packed away, drying-cages, suspended from the roof of a hut or tent, are absolutely necessary. These can be readily made from old packing cases, but a few square feet of wire gauze must be provided for the back and front of the cages, and the cord by which they are suspended must be threaded through a small calabash containing oil, or better, naphthalene, to prevent ants descending from the roof. The cages may be arranged to take to pieces and put together again readily; one, for birds, should be about 30 inches long by 18 inches high and 12 inches broad; the other, for insects and other small specimens, may be about one-third less. They should have folding doors in front, with panels of wire gauze, and the backs wholly of the gauze; the sides fitted with racks to hold six or eight plain shelves, which in the smaller cage should be covered with cork, or any soft wood that can be obtained in tropical countries.

A strong ring fixed in the top of the cage, with a cord having a hook attached at the end by which to hang it in an airy place, will keep the contained specimens out of harm's way until they are quite dry, when they may be stowed away in suitable close-fitting boxes. An even simpler and perfectly effective plan is to take a number of pieces of stout wire each about 18 inches long, bend each end into a loop, and round the middle solder a funnel-shaped piece of tin to contain powdered candle-naphthalene. The upper loop of each wire can be secured with string to a rafter and between the lower loops flat boards, or a series of boards can be suspended on which skins may be placed to dry. This method is usually safe, but some ants will even cross naphthalene. A few drops of White Beechwood creosote is more effective but must be renewed about twice a week.

WHERE AND WHAT TO COLLECT

The countries whose natural history is now the least known are New Guinea, the highlands of Mindanao and other Philippine Islands, Formosa, Tibet, Indo-China, and some parts of Central Asia, Equatorial Africa, and Central South America. A special interest attaches to the indigenous products of oceanic islands,

i.e. islands separated by a deep sea from any large tract of land. Those who have opportunities could not fail to make interesting discoveries by collecting specimens of the smaller animals (insects, mollusca, etc.) and plants in these isolated localities. Both in continental countries and on islands the truly indigenous species will have to be sought for on hills and in the remote parts, where they are more likely to have escaped extermination by settlers, and the domestic animals introduced by them. In most of the better known countries the botany has been better investigated than the zoology, and in all these there still remains much to be done in ascertaining the exact station, and the range, both vertical and horizontal, of known species of animals and plants. One cannot too strongly insist on some effective means to record the *exact locality* and *date* of every specimen.

A traveller may be puzzled, in the midst of the profusion of animal and vegetable forms around him, to know what to collect and what to leave. Books can be of little service on a journey, and he had better at once abandon all idea of encumbering himself with them. A few days' study at the principal museums before he starts on his voyage may teach him a great deal, and the cultivation of a habit of close observation and minute comparison of the specimens he obtains will teach him a great deal more. As a general rule all specimens which he may meet with for the first time far in the interior should be preferred to those common near the civilized parts, and he should bear in mind that the few handsome kinds which attract the attention of the natives, and are offered for sale to strangers, are almost sure to be of species well known in European museums. He should strive to obtain as much variety as possible, and not fill his boxes and jars with quantities of specimens of one or a few species, but as some of the rarest and most interesting species closely resemble others which may be more common, he should take every opportunity of comparing the objects side by side. In most countries the truly indigenous, and often the rarest, species are to be found only in the mountains at considerable elevations and in the primitive forests, the products of cultivated districts being nearly all widely distributed and well known. In botany, the traveller, if obliged to restrict his collecting, might confine himself to those plants which are remarkable for their economic uses; always taking care to identify the flowers of the tree or shrub whose root, bark, leaves, wood, etc.,

are used by the natives, and to preserve a few specimens of them. But if he has the good fortune to ascend any high mountains not previously explored, he should make as complete a collection of the flowering plants as possible, at the higher elevations. The same may be said of insects found on mountains, where they occur in great diversity, on the shady and cold sides rather than on the sunny slopes, under stones, and about the roots of herbage, especially near springs, on shrubs and low trees; for upon a knowledge of the plants and insects of mountain ranges depends the solution of many curious questions regarding the geographical distribution of forms over the earth. Do not neglect the smaller Batrachians (frogs, salamanders, etc.), especially the extremely numerous family of tree-frogs; the arboreal, or rock-haunting species of lizards seen out of reach, and the swift-running forms that inhabit sandy plains may be secured with a charge of dust-shot, the saloon pistol being especially handy for this purpose. Snakes should be taken without injuring the head, which is the most important part of the body; a cleft stick may be used in securing them by the neck, or they may be shot, and on reaching camp placed in the jars of spirits. Make as large a collection as possible of the smaller fishes and tortoises of lakes and rivers.

"As a result of the twelve months collecting, 1500 Mammals, 1250 Reptiles and Amphibians, and 4000 invertebrates consisting of Spiders, Centipedes, Molluscs, and parasitic Worms, were obtained. These all reached home in an excellent state of preservation. In addition, voluminous data relating to them, together with narratives, word lists of native languages, and maps, were compiled, filling some twenty foolscap note-books by the end of the trip. Unfortunately the photographs represent only a little under half of those taken, owing principally to deterioration of the negatives after developing and the excessive humidity of the climate.

Drawings of the feet, ears, and other external features of all species of mammal were made from the freshly killed specimen. The soft parts were always examined, the stomach contents preserved and the uteri, in the case of females, subjected to special treatment for the purposes of embryological study. One hundred and fifty-four of the latter were obtained, including several in a pregnant condition belonging to species that have not previously been investigated. The external features and coloration of every individual mammal and Frog were recorded; a most laborious process which probably occupied more than half our actual hours of work while in the field. Every mammal was examined both for internal and external parasites.

There were twelve main objects projected for collection, apart from the research in the field, of which eleven were obtained, the only exception being actual specimens of a freshwater Dolphin suspected of inhabiting the waters of the great African rivers. The original scheme of work was carried out to

the letter in every branch, and a most gratifying collection of material together with a number of unexpected items of great value and interest obtained. Of particular note among the latter are five hundred preserved and twenty live Podogona, aberrant Tick-like Arachnids, previously represented only by a handful of scattered specimens in the great Museums of the world."

Sanderson. Cameroons. 85.135.

COLLECTING AND PRESERVING LARGE MAMMALS

The larger mammals will be obtained by shooting; in Muhammadan countries prevent the native hunters from cutting the throats of animals when shot to render the meat fit to eat under Muslim law, as this ceremonial observance often damages the skin. Make careful measurements of any animal intended for mounting. Write these measurements on the label with full particulars of date, sex, locality, altitude; with a corresponding ticket on the skull which will be separately prepared.

In skinning make as few incisions as possible and confine them to the middle line of the under-surface of the body and to the inner sides of the limbs. With horned animals, make an additional incision from the crown of the head down the middle of the neck so that horns and antlers can be passed through. After skinning the carcase remove all fragments of flesh and fat still adhering; give special care to the ears, lips, and eyelids. Preserve skin with alum well rubbed in; arsenical soap for the more delicate parts, such as the eyelids and ears.

Preserve skull and limb bones, and the whole skeleton if the animal is likely to prove rare. After rough cleaning soak the skeleton a few hours in water and thoroughly dry; do not disarticulate more than necessary for convenient packing. Sew up skins and skeletons in cotton or any convenient material before packing in cases, and do not pack till thoroughly dry. Pack skeletons always in separate cases from skins.

SMALL MAMMALS

Collect small mammals best by trapping in runs through the grass or where there are signs of holes or burrows. The most convenient traps for ordinary use are the ordinary "break neck" spring traps of the sizes for rats and mice; for larger animals a gin trap. For bait try almost any food stuff, mealies or other grain, fat, cheese, or scraps.

In most countries the best results will probably be obtained by

help of the natives, especially the boys and children. They will soon learn to use the European traps, and often have their own methods; with encouragement they will bring in many specimens.

"Lines half a mile in length with traps at 8-foot intervals were thrown out in every direction, and were only removed when the 'trapping-graph' was completed. This is a curve varying in extent, but always similar in form. In the grass country, this curve starts at its maximum, and falls gradually until it reaches a point where it shows that only six per cent. of the traps are 'taking,' after which it remains constant over a considerable period. In the forest country however it invariably starts with a zero reading and rises to the maximum number of animals caught on the third or fourth night, after which it falls away to between five per cent. to three per cent. in about twelve days. Some trap lines remain entirely negative, for reasons that are obscure, but which are perhaps related to excessive humidity, in territory that does not otherwise support a fauna adapted to such conditions. All trapping in the forest is rendered both difficult and meagre in results by the abundance of natural food: an almost uninterrupted layer of fallen fruits which covers the entire ground.

There were three other methods of obtaining mammals which we constantly employed in the forest. First, shooting at night, for nocturnal types such as dog-tailed Lemurs, Flying Squirrels, and the Potto, in which case we made use of the method known as 'jacking,' that is to say, shooting with the aid of powerful torches in order to illuminate the animal's eyes which we would not otherwise have seen. Secondly, the native hunter and the two head 'skinners' would go at daybreak to the feeding grounds of duiker, mongoose, and squirrels. As a result of their activities we obtained a large series of these types. Thirdly, organized search for hollow trees was made every other day during the ordinary routine of turning over huge logs under which invertebrates were to be found. These hollow trees were carefully marked and reported to me in the evening by each of the native collectors when he returned to camp. Next day, armed with bales of dry grass or leaves, axes, guns, and tins of kerosene, the whole camp set out to fire those trees that seemed to me, at any rate, to be the most promising. In each case an area had to be cleared all around in order to obtain an uninterrupted view of the head foliage. Everybody had his job. Two fire-lighters enlarged the hole at the base of the tree to gain adequate access to its hollow interior and then built a bonfire within composed of a bedding of dry sticks, a central layer of highly inflammable material, and a roofing of green leaves which produced volumes of smoke when lighted; everybody else felled the surrounding trees and cleared away the bush. When all was ready, kerosene was poured into the base of the tree and a match applied; then each of us, holding a gun, stood as far back as possible in company with a boy who acted as loader and an accessory pair of eyes to watch for animals leaving the fated tree. The remainder of our little army was posted around at regular intervals to pick up those specimens that fell by gun-fire or dazed by the smoke. By this method very many of our best specimens were obtained, mostly of species that were otherwise not seen, like *idiurus* (the Pygmy flying squirrel),

arboreal dormice, certain squirrels, and several bats. If animals were forthcoming the boy who had found and marked the tree received a 'dash' in money proportionate to the value of the specimens obtained."

Sanderson. Cameroons. 85.123.

MATERIALS AND TOOLS

The more necessary appliances are a large skinning knife, two scalpels, a pair of scissors (5-inch pointed), a pair of dividers, a mm. rule, a pair of pliers for cutting wire, and a pair of forceps; arsenical soap or alum and arsenic powder for preserving; cotton wool, sawdust, and wire. All these can be obtained from Messrs. E. Gerrard and Sons, 61 College Place, N.W.1, or from Mr. W. F. H. R. Rosenberg, 57 Haverstock Hill, N.W.3, or from the Stores in London which have a Natural History Department.

"We thought that rope-shooting machines might help, and brought for the purpose a rocket-firing apparatus and a line-throwing gun. We brought 2000 feet of rope for hauling people up, and suitable pulleys for making block-and-tackles. Also we had a parachute sling of the pattern used in the Royal Air Force. We brought rope ladders in 60-feet lengths which we thought might give access to the canopy and some freedom of movement in the tree-roof. We were advised to take out pointed iron bars, with mauls for driving them into the tree-trunks, with the idea of making spike ladders up some of the large trees. We had wooden 6-feet scaling-ladders which could be fitted to one another; also sprays for shooting poisons at noxious insects, and safety belts of the type that painters use, for wearing when in difficult parts of the trees. But although we seemed to have all the equipment desirable, I pinned my faith on getting help from Indians, who, in the course of their lives in the forest, were accustomed to climb trees.

In this hope of native help we were fortunately not disappointed. Mr. Wood, to whom I had explained our requirements, got us two Indians from the Pomeroon river who were accustomed to climb Balata trees. Their object is to bleed the trees, from which they extract a species of rubber. Our two balata-bleeders, Jothan and Sebico, turned out of greater value in fixing our first ropes than did our mechanical weapons of propulsion. We fitted them with boots and climbing-irons, and, unless a tree was hopelessly rotten or was surrounded by a tangle of pendent bush-ropes, Jothan or Sebico never failed to climb it. Metaphorically speaking, we got up the trees on the spikes of our balata-bleeders.

The rocket-firing apparatus was first put into action. It sent its missiles with impressive force into and far above the canopy, but the difficulties were in aiming them over a particular branch and in getting the rope to ground again without its being hopelessly entangled overhead. Jothan and Sebico then got on their climbing-irons, and, with circles of rope round both their bodies and the tree-trunk, carried a light rope up to the first fork at a height of 75 feet. Earlier in the day a block-and-tackle had been got in readiness, and one end of this they hauled up and fixed to a suitable branch. We now had a hauling-up apparatus in position. A flat seat was then made with pieces

of sapling after the fashion of a bo'sun's chair, and attached to the lower end of the block-and-tackle. Seated on this a man could be hauled up into the tree. The arrangement worked fairly well, but one got scraped by twisting and banging against the tree-trunk. We then replaced the seat with a parachute sling, which only made the twisting and swinging worse. In the end our Indians made us a kind of armchair out of straight sticks and bits of ration boxes, and this was not only efficient but extremely comfortable. One could sit in it for hours observing with ease.

One thing that must always be kept in mind is the possibility of white-ants eating the ropes. The fastenings must be periodically inspected, and petroleum or some other insecticide sprayed over the ropes wherever they touch the tree. Any one wishing to repeat this kind of work would be well advised to use only tarred rope, which insects will probably refuse to eat. It should be remembered that the rotting effect of the climate shortens considerably the life of ropes. The ceaseless shrinking and slackening under frequent rain put a heavy strain on rope ladders. I considered that ours required replacement after being in use for two months. A quantity of vaseline is a necessary part of the equipment. Much is required for greasing blocks, and it can be smeared over ropes where they cross branches in order to keep white ants away. A knowledge of splicing, whipping, and simple knotting is necessary. Indians cannot help in this direction, since they work with the natural bush-ropes.

From the ground we used a net with a long handle to sweep the vegetation and catch small animals up to a height of 30 feet. From a canopy platform the net could also be used to sweep the branches of the observation tree or those of its nearest neighbours. Our wooden scaling ladders turned out useful, though not for the purpose originally intended. I thought that we might have been able to spread them in the canopy, lengthening and shortening them as conditions required. But we found that for this the rope laddering was more effective. The scaling-ladders were then turned to the examination of the tree-trunks and employed for collecting bark-inhabitants at heights which, without them, it would be difficult to reach. Some creatures were secured by rather odd methods. Duffield, with a 12-bore scatter gun, shot large buprestid beetles while in flight through the canopy; and our Indians with bows and arrows shot birds, lizards, rats, mice, beetles, butterflies, and other insects. But of all the devices for canopy collecting the automatic traps were the most productive, and the best baits with which to set them is carrion by day and lamps by night.

We had brought out with us cylindrical spikes, 14 inches long, 1 inch in diameter, and ending in wedge-shaped points. The object was to build a spike ladder. They were to be driven into the trees with 8-lb. mauls. In practice, however, we found that the trees would not take them. The largest trees would not admit them more than an inch or two. I was able to get them into some of the softer trees, but on the whole they were of little use. Owing to the supposed terrors from noxious insects we were equipped with syringes for squirting poisons. To some slight extent they were useful, but the difficulties from this cause were much exaggerated, and few trees in the forest are likely to prove inaccessible on account of insect pests."

Hingston. British Guiana. 76.11, 16.

BIRDS

Collect small birds with a small-barrelled gun or a walking-stick gun, with lightly loaded cartridges. Wrap them in soft paper, first plugging the mouth, anus, and any shot holes with cotton wool. If it is very hot or delay in skinning is likely, moisten the cotton wool in spirit or weak formalin. The smaller duller coloured bird forms are likely to be of the greatest interest; the brighter species are almost sure to be well known. Forest birds also likely to be of interest as always difficult to locate and to retrieve. Some collectors attract birds by laying grain or other food along forest paths, visited early the following morning.

For skinning, patience, practice, and a few lessons before leaving England are better than pages of directions.

Full directions are in the British Museum Hand Book. With the large-headed birds such as parrots, woodpeckers, and ducks, the skin of the neck cannot be turned back over the head; make an incision along the nape through which the skull can be passed and cleaned; then close the cut by two or three stitches. Label the skin and thoroughly dry before packing in soft paper, to prevent the feathers from ruffling.

Tools and materials for skinning birds are a scalpel or pen-knife; a pair of strong nail scissors; arsenical soap; bleached wool or tow; a sharp pointed awl or darning needle; fine white sawdust and plaster of Paris are useful adjuncts. All these may be obtained from Rosenberg or Gerrard. (See p. 341.)

Write on labels the full data of sex, date, locality, and colour of soft parts.

Sexing birds.—When the body has been removed from the skin make an incision along one side and turn it back to expose the intestines; push them on one side to display the roof of the body cavity against which lie the kidneys, dark red masses on either side of the middle line. Lying upon the kidneys are the sexual organs; large and conspicuous and not difficult to trace if the bird is breeding; but if the bird is young and not in breeding condition, often difficult to detect.

In a male bird two oval white (or sometimes dusky) bodies lie on either side of the middle line on the upper part of the kidney; these are the testes, and from them two white tubes or ducts run backwards towards the vent. In the young bird, or in old ones after the breeding

season, they become very small and often difficult to detect; take care not to mistake for them the supra-renal bodies, two yellowish bodies which lie at the front edge of the kidneys further forward, present in both sexes.

The position of the ovary in the female bird corresponds to that of the testes in the male, on the left-hand side of the bird (right-hand as looked at from above): the ovary is a yellowish mass of ova of sizes up to an almost full-sized egg. The oviduct, a coiled tube not quite in contact with the ovary, though opening quite close to it, runs down towards the vent. Unless the sexual organs can be recognized without doubt, it is better to mark on the label "sex doubtful."

The usual signs for the two sexes are ♂ male and ♀ female; *i.e.* the shield and spear of Mars, and the mirror of Venus.

"Collections were made of plants and insects; the area most thoroughly worked being the north-west coast. Ornithologically the most important subjects studied were distribution and non-breeding. With regard to the latter, 1936 proved to be a non-breeding year, so that the expedition had an opportunity to study non-breeding in normal and abnormal years. The non-breeding was exceptionally high even in the former. Whenever possible observations were made on animal life during the winter; the population at the leads of open water being especially interesting.

"A detailed study was made of the sexual behaviour and breeding activities of several species. The most interesting of these was the purple sandpiper, and it was possible to compare the sexual behaviour of this species with that of the closely allied sanderling, and also the grey phalarope."

Glen. North East Land. 90.309.

LAND INVERTEBRATES

Among these, Spiders, Scorpions and their allies, Centipedes and Millipedes, Woodlice, Landsnails, and Slugs, and Earthworms, all "land animals," are not so popular or so often collected as Vertebrates and Insects, and collections may include interesting new forms.

Spiders are both nocturnal and diurnal; some are found under stones or rotten logs and under decaying bark; others build their webs among bushes and can often be shaken from the web into a wide-mouthed bottle, or by beating bushes or flowers over a sheet of paper. Look out for trap-door spiders, which close the mouths of their burrows with a movable lid, found on the ground or upon the trunks of trees, but difficult to detect.

Ticks, which are allied to spiders, are chiefly parasites on living vertebrate animals; label with the name of the host.

Land mollusca and slugs should be drowned in jars filled to the

brim, so that they die fully extended: then placed in 40% alcohol which must be changed daily for 4 days: then transfer to 70% alcohol and pack.

FRESHWATER INVERTEBRATES

Freshwater Crustacea are often of very restricted range, and of exceptional interest if collected in out-of-the-way places. Fish in ponds or lakes with a fine muslin ring-net, with a conical guard of wire gauze at the mouth when working among weeds. Or take samples of mud from the bottom of dry or half-dry ponds; place the samples in glass tubes, label, and send to the laboratory at home.

Preserve invertebrates in spirit and pack in jars or tubes; change the spirit before finally packing them for transmission; wrap some larger forms in paper and put a wad of paper at the top of the jar to prevent shaking and breaking delicate specimens.

EARTHWORMS: *By Lieut.-Colonel J. Stephenson*

Earthworms should be collected in spots remote from cultivation; owing to the ease with which they are transported and naturalized, those collected from gardens, etc., often turn out to be ordinary European species.

Their two chief requisites are moisture and vegetable nutriment in the soil; thus they are not found in dry or desert soil, or in sand. Even in regions which, though well clothed with vegetation, have dry and wet seasons, they are not found in the surface layers in the dry months; they retreat deeply into the ground and remain coiled up till the onset of the rains. Thus, in South India it is necessary to dig down as far as 10 feet in the dry season before obtaining worms which in the rains were found crawling on the surface, or in the surface layers in moist places; look also under stones in shallow water near the banks of streams, and among the roots of the vegetation at the water's edge. Try driving a stake into the ground; the vibrations are said to bring our ordinary *Lumbricidae* to the surface, and the same may perhaps be the case with other families also.

If there is time, preserve earthworms thus: Place them in water to cover them and narcotize them by adding spirit in small amounts every few minutes. When they are thoroughly limp, fix by placing them in 10 per cent. formalin and keeping them straight till they stiffen; leave overnight in the formalin and transfer them to strong alcohol the next day.

More simply, put the worms in strong spirit, keeping them as straight as possible till they become fixed. If the spirit is not strong enough, the results are disastrous. The greater part of the body of earthworms, as of other animals, is water, and if preserved in their own volume of spirit (of 90 per cent.), the preserving fluid is actually an alcohol of hardly more than 50 per cent., a very indifferent preservative; while anything more dilute is a macerating agent.

REPTILES AND AMPHIBIANS: *By Dr. Malcolm Smith*

Amphibians and Reptiles can be collected in many ways. Wherever possible enlist the services of villagers, who for a small reward will usually bring in many specimens. The majority will be common species of the neighbourhood, and this must be allowed for a few days until they get used to collecting; afterwards they can be told that no more of the common species will be required. An extra reward occasionally for unusual specimens will keep them up to the mark.

Collect frogs during the day by hunting up streams, turning over the stones and boulders under which they hide. Some species sit out more or less in the open; they can be caught by hand or shot with a pistol charged with a small quantity of dust shot. Lizards by the same method. But three or four hour's collecting after sunset with a lamp will often produce more than three or four whole day's collecting in daylight. Some species, tree frogs in particular, can be tracked down by their calls.

"Noticing that many rare and interesting species, otherwise never seen, were attracted to the lights of the camp, we developed a method for obtaining these types in greater numbers. A white sheet was hoisted perpendicularly among the foliage of the forest trees, and being illuminated by a strong light, attracted countless nocturnal insects. Periodically small groups of tree-frogs, or more seldom single individuals, would suddenly appear, adhering to the white surface as if by magic. Hurriedly swallowing a few insects near to hand, they would often as mysteriously vanish again before our unwieldy hand-nets could close in on them. As however our technique approached perfection, many proved either too greedy or insufficiently agile."

Sanderson. Cameroons. 85.124.

To kill snakes hit them smartly over the back with a stick a short distance behind the head so as to break the backbone. If properly given one blow is sufficient, and although the snake will wriggle for some time it cannot escape. Never damage the head.

In tropical countries snakes seldom bask in the sun as they do in temperate climates. The arboreal species must be searched for in bushes or trees. The ground species are nocturnal or crepuscular in their habits and spend the day hiding under stones or logs.

Carry specimens while actually collecting in strong cloth bags.

Alcohol is best for preserving amphibians and reptiles, though formalin is now commonly used: cheaper and easier to carry as little is required, but with two disadvantages. It destroys colours (green for instance is turned black), and unless very diluted hardens the specimens so that they cannot be manipulated afterwards. Commercial formalin is sold at strength 40 per cent. and should never be used stronger than 2 or 3 per cent., so add about 8 parts of water. If alcohol is used methylated spirit will do, as sold at about 94 per cent. Commercial (mineralized) spirit turns cloudy on addition of undistilled water, but this does no harm to the specimens. Put small reptiles and all amphibians into 50 per cent. solution for two days and after that into 75 per cent. It is very important to make a slit or two, according to size, in the belly to allow the preservative to enter. Large lizards and snakes are best skinned first to economize storage space. Skin out trunk and limbs leaving head and feet intact; roll up and place in the preservative. Put small tortoises straight into alcohol after making a good slit in each groin. With large specimens place the head, limbs, and tail in spirit; the shell can be kept dry after removing the contents.

Label all specimens with the locality referred to the nearest well-known town, stout paper written in pencil. After the specimens have set, wrap them in cloth to prevent chafing. Many colours, particularly yellow and red, fade quickly in alcohol, so note the living colours before they have been destroyed.

Alcohol becomes weaker with the addition of each specimen, and too many should never be placed in one jar. If one large tank is used keep the spirit up to strength by adding more occasionally. Too weak a solution makes a sodden specimen, too strong hardens and shrinks it, and no treatment afterwards can repair the damage done.

"The crocodiles were still more remarkable in this way; we were able to walk up close to them as they basked on the shores of the crater lakes: a great contrast to the crocodiles near our base camp, where they are persecuted by the Turkana for food and are almost impossible to shoot and quite impossible to photograph. The Central Island crocodiles however, having never seen

man and having no other enemies, showed no interest at our approach, and on occasions we threw stones upon their heads from two or three yards' range before they would consent to move from their hiding-places into the open to be photographed.

In spite of their complete adaptability to water life crocodiles do not seem to traverse big stretches of open water, and so these tame crocodiles must have lived for many generations without mixing with those of the other shores of Lake Rudolf. Another instance of this is to be found in Lake Victoria. Almost in the middle of that lake a little island called Godsiba is entirely free from crocodiles, and consequently it is possible to bathe there with impunity, although all other parts of the Victoria shores are very dangerous. In this case the nearest mainland is 36 miles away and the crocodiles have never traversed this stretch of open water."

Worthington. Lake Rudolf. 79.279.

"Capt Taylor became interested in reptiles whilst serving with the Anglo-Italian Boundary Commission in 1929–1930, and sent back several hundreds of specimens. These first collections came as a great surprise to us, for although we realized that our knowledge of the Somali fauna was not complete, we did not realize how very ignorant we really were. In all, representatives of close on a hundred species were obtained, of which fourteen or fifteen are new to science. In these days this is a very high proportion indeed, . . . The Ethiopian mountains must form a very effective barrier to the free movement of terrestrial animals, and as a result there are only two corridors open for migration into Somaliland. Those reptiles which have entered from the north-west, from the dry Sahara, have undergone no change, but those entering from the south, from a relatively well-watered area, have become very much modified. And since there is some evidence that the present aridity is very recent indeed, the corollary is that species-formation in that area must have been going on very rapidly." *H. W. Parker (N.H.M.) in discussion.* 87.307.

FISHES: *By J. R. Norman*

To collect marine fishes without special gear is difficult, but much may be done by watching fish-markets for rare specimens, by cooperation with professional fishermen, or by searching rock-pools between tide-marks. For these littoral forms a small net is useful, but larger collections are more readily obtained by judicious use of chloride of lime or other poison in the pools. Freshwater fishes from the lesser-known parts of Africa, South and Central America, Central Asia, Malaya, Siam, China, etc., are badly wanted by the national museum, and collections from these regions are almost certain to yield new or rare species. Unless seine nets, fish-traps and other gear are obtainable, the collector depends largely on native fishermen, from whom important information as to habits, etc., may often be gained.

By far the best preservative for fishes is alcohol, the best and strongest obtainable, diluted to the strength required. If the necessary permit has been secured, use industrial methylated spirit; arrack, brandy, or rum make fair substitutes. Full particulars will be found in 'Instructions for Collectors. No. 3. Reptiles, Batrachians and Fishes,' issued by the British Museum (Natural History), price threepence; only one or two points of special importance need be stressed here.

The body of a fish contains much water, so that the alcohol soon becomes diluted. For this reason, change the spirit twice, three, or even four times before the specimens are finally packed for shipment home. As a general rule start in alcohol of about 40 per cent. strength, and transfer to 50, 60, and finally to 70 or 80 per cent.; but in the tropics, where decomposition is rapid, it is often necessary to use much stronger spirit at the start. Make one or more incisions, according to size, in the belly of the fish to allow spirit to penetrate.

Where alcohol is not obtainable, or if the price is prohibitive, use commercial formalin (formaldehyde) mixed with about 20 parts of water; since a small bottle will make a large quantity of the fluid, its advantage is obvious. But formalin may damage the delicate tissues, especially if they are kept long in the solution or if its strength is too great; prefer alcohol.

After adequate preservation pack the specimens for transport in the special zinc-lined wooden tanks, and boxes of screw-capped jars, supplied by the British Museum. Common earthenware jars closed with cork or rubber make very efficient substitutes, and empty petrol cans even better; wooden casks are not recommended, especially for hot countries. Wrap all specimens carefully in muslin, old rags, or even newspapers, before final packing, to prevent damage to fins, scales and the like; put very small specimens in tubes or bottles sealed with bees-wax or a mixture of bees-wax and vaseline (not with sealing wax). Pack any remaining space with wood-wool, rags, or paper to avoid damage by movement during transport. Attach numbered labels with locality, date of capture, etc., to each specimen or insert in the wrapping; a second label within the mouth or under the gill-cover minimizes danger of confusion: write with soft lead pencil on unsized paper, or Indian ink on parchment.

Dried skins of fishes are not generally suitable for study, and

collection is not recommended unless other methods of preservation fail. Preparation of skeletons requires skill and practice, and is best left to experts.

Tanks, boxes of jars, labels, muslin, alcoholometers, etc., are all supplied by the British Museum (Natural History) to *bona fide* collectors desirous of increasing the national collections. A personal interview with one or more members of the museum staff is desirable before departure.

INSECTS. *By L. E. Cheesman*

Collecting insects in any part of the world is of great importance. It has been neglected in the past except for striking and beautiful forms, but as the total number of insects approaches that of the rest of the animal kingdom much material is needed. Travellers by carefully collecting small and inconspicuous forms may give valuable assistance in solving insect problems; not only those of general interest, but also of economic importance concerning the medical and veterinary sciences and agriculture. The taxonomy is of paramount importance because a species must be identified before biological records can be attached to it; yet this work is often held up for lack of entomological material, far more being needed than is at present available in our museums. Field observations of the habits, etc., of insects may prove extremely useful.

Diurnal insects are more or less easily found, but there exists a far larger proportion whose activities are carried on by night. All habitats should be exhaustively explored for such insects, which conceal themselves in crevices of bark, rotten stumps, fallen logs, branches, blossoms, fallen fruit, seeds and roots. Many kinds shelter in dry leaves and detritus which collect in tree-holes, branches, or hollows of the ground; others under dry clods, or in the soil. Crickets and beetles are found in hollow stems, of bamboo, coarse grasses and reeds, etc. Grassheads and blossoms should be dissected in a very fine net for minute species.

Trees should be felled and all parts examined, including epiphytic plants, moss, and lichens; small trees in bloom may yield species feeding on honey or pollen which will not be taken otherwise, and which do not escape when the tree falls.

Collecting in rivers, streams, and stagnant pools is specially important. There are insects which run about on the surface in addition

to the aquatic forms; others are among dead leaves or mud, or under stones, or submerged logs and sticks.

By sweeping herbage with a special net very small and rare insects can be obtained; also by beating foliage with a stick while a beating-tray is held underneath. An automatic insect-trap has proved to be very effective. A sure method of collecting large numbers of moths and other insects which are attracted by light is by using a screen illuminated by powerful lamps, the best type being Primus vapour lanterns, either for burning petrol or paraffin.

The British Museum provides collecting, preserving, and packing equipment if application is made to the Keeper of Entomology. For butterflies, moths, and dragonflies, the ordinary cyanide killing-bottles of stock sizes are required, and in addition several large tubes of the same in order that the small, delicate species may be separated. After remaining in the drying-trays for about two days all except the fat-bodied insects can be packed individually in special paper, or newspaper or any absorbent paper can be used. Large, thin-bodied flies can also be papered, but the large-bodied are better pinned. For collecting small flies tubes loaded with chloroform are useful. Killing-bottles and tubes should not be filled with too many insects, it is as well to use tissue paper to separate them in layers. Grass-hoppers must be kept in a separate bottle as they damage other specimens: the larger kinds require a week or more in the drying trays, or should be eviscerated; they travel best in paper cones, but smaller kinds and all hard-bodied insects such as *Coleoptera*, *Hymenoptera*, and *Hemiptera* are packed between layers of crêpe paper, or in coarse sawdust in carton boxes. A few drops of carbolic and creosote on wool deters mould and destructive insects. Ants and *Homoptera* must be collected in tubes of methylated spirit.

Notes on locality, habitat, date, etc., are written on the papered specimens or the boxes. For spirit material sheets of numbers can be printed to correspond with the numbers of the field notes, or they can be written in Indian ink. Tubes must be filled to the brim before packing, and dipped in paraffin wax so that the cork is well protected.

HINTS ON BIOLOGICAL COLLECTING IN POLAR REGIONS. *By Colin Bertram*

Polar expeditions suffer more than others from uncertainty of movement and location. The biologist may intend detailed oceano-

graphy or a study of inshore marine life, but ice conditions or sudden geographical discovery may make the most profitable line a study of seals. Prepare material equipment, and mental attitude, for such reverses, as sudden as unavoidable.

Much technique of collecting is exactly as in temperate places, but peculiar difficulties arise simply from the cold. The first is mental, a very natural tendency to scamp the work and get it finished as soon as possible. Chilly and inefficient fingers must be frequent; swing the arms from the shoulders in vertical circles, impelling the blood back into the fingers.

In the cold apparatus and methods must be kept simple. For collecting small insects, spiders, and mites in summer, use the sucking tube; its fragile glass barrel may be replaced with good quality celluloid piping. For *Collembola* and the smaller mites bring back earth and debris and put them through a small portable berleze funnel operated with a fill of boiling water instead of a naked flame, thus safe to leave untended in tent or hut. Arctic and antarctic plants, largely mosses and lichens, many of them compact or knob-like and impossible to press, may be put in dishes and dried in a slow oven overnight, then put away in tins; but re-dry at intervals; condensation will ruin plants and bird skins. Often it may be best to put mosses and foliaceous lichens into weak formalin at once.

Specimens packed away in tubes or jars of pickle are not really safe: the preservative may freeze and split the bottles if they are more than three-quarters full. Remember that 4 per cent. formalin will freeze very much more easily than 70 per cent. spirit, but either solidifying may ruin the specimens, so keep filled jars in a place not far below freezing. Even 40 per cent. formalin in bulk should be mixed with strong spirit. Bouin's fixative freezes at a lower temperature than 4 per cent. formalin, and is very useful for preserving even delicate specimens during times of stress. A spirit-formol-salt solution (3 parts 1 per cent. formalin saturated with common salt mixed with 1 part of 96 per cent. alcohol) is very good for large foetuses, and for birds that can neither be skinned at once nor safely kept frozen. To pack large numbers of tubed specimens, plug the tubes with cotton wool instead of corks, and arrange in large kilner jars of preservative, the centre of the jar packed with wadding.

One man can drag a tow-net parallel with the shore with the otter-board. Tow-nets, dredges and fish-traps may be worked through

holes in sea or lake ice; if a hole is wanted again, before leaving fill completely with snow. You can dredge and catch plankton through the ice by a rope running through two holes, but it takes ingenuity to rig the continuous rope for the first time, particularly after the freeze-up. When the fine silk plankton net comes to the surface it will freeze at once, so treat its brittleness carefully. The catch will quickly become solid unless put into a thermos and corked up, or into a jar in a felt-lined box kept warm with those heating pads such as rheumatic people use.

Kill seals or other large mammals oneself. If skulls are wanted seals may be killed with a heavy soft-nosed bullet in the neck. Polar birds, particularly those of the Antarctic, are often extremely blubbery. When skinning use dead plaster alone or mixed with the sawdust to overcome this trouble. Particularly in describing the soft parts of birds use a standard Ridgeway Colour Chart.

For hydrology under the ice adapt a sledge to carry a drum of wire mounted as a simple hand winch to make soundings and vertical plankton hauls. For water temperatures a submarine thermograph fitted with a clock to revolve once in two hours will measure a series of depths in one operation.

CHAPTER XVIII. ANTHROPOLOGY

THE last edition of this book contained a chapter by the late Sir E. B. Tylor which, though written many years before, was then in 1921 confidently recommended as an adequate sketch, and sixteen years later is still approved by high authority. It contained secondly a series of queries of anthropology by the late Sir A. W. Franks, which is still useful.

But we are advised that it is no longer useful to include directions for measuring crania with calipers, nor for recording the measurements of bones that can not be collected. The technique is now so specialized that amateur measurements can hardly be successful. Moreover most subjects strongly resent being measured. Careful photographs full and side face are now recommended rather than attempts at measurement. This being so we print a summary of Tylor and the questionnaire of Franks, with the warning quoted from a note by Dr. R. R. Marett in the 10th edition that the traveller in these latter days, instead of opening up fresh fields must for the most part be content to work over old ground more carefully than his predecessors. Unless, therefore, he is prepared to discard superficial means of observation and devote himself to a critical and intensive study of the available facts, he had much better leave the subject alone.

For more detailed information, see 'Notes and Queries on Anthropology' (six shillings), published by the Royal Anthropological Institute, 52, Upper Bedford Place, London, W.C.1.

"I took cranial calipers with me and made some fifty head measurements, heights, and fathoms, and took a full-face and profile portrait of some fifty specimens. This material is the first of its kind to be brought back from this part of Arabia, as the native dislikes being pawed by infidel hands, and in many cases refuses angrily even to be photographed."

Thomas. Rub' al Khali. 78.212.

A SKETCH OF ANTHROPOLOGY. *By the late* SIR E. B. TYLOR

PHYSICAL CHARACTERS

On first coming among an unfamiliar race the traveller is apt to think them almost alike, till after a few days he learns to distinguish individuals more sharply. This first impression has a value, for what he vaguely perceived was the general type of the race. Among tribes

who for generations have led a simple uniform life and mixed little with strangers, the general likeness of build and feature is very close, as may be seen in a party of Caribs or Andamaners, whose uniformity contrasts instructively with the individualized faces of Europeans. A traveller among a rude people, if he has something of the artist's faculty of judging form, may select groups for photography which will fairly represent the type of a whole tribe or nation. Such portrait-groups give the general idea of a race; characteristic features should be treated separately. To do justice to the Tartar eye or the Australian forehead, it must be carefully sketched or photographed large.

How deceptive mere unmeasured impressions of size may be is shown by the example of the Patagonians, who, though only averaging 5 feet 11 inches, had the reputation of a race of giants. Measurements with a measuring-tape and a 3-foot rule with sliding square are good if taken with proper precautions. If only a few can be measured, they should be of average build, full-grown but not aged: much better to measure a large number (never less than thirty) taken indiscriminately as they come, and to record the measurements with sex, age, name, locality, etc. Such a table represents on a small scale the distribution of stature, etc., in the whole people. Gigantic or dwarfish individuals, if not deformed, are interesting, as showing to what extremes the race may run. The ordinary measurements are height, girth round chest, fathom or length of outstretched arms, length of arm from shoulder and leg from hip, length of hand and foot. Body measurement needs skill in taking the corresponding points, and all but the simplest measures require some knowledge of anatomy, especially with skull measurements. The more conspicuous, such as the relative length and width of the skull, roughly indicate the marked difference between dolichocephalic or long-headed peoples, like the African negro, and brachycephalic or short-headed peoples, like the Kalmuks and other Tartars. The degree of prognathism or projection of jaw, in some races, as the Australian, gives a "muzzle" unlike the English type. Where practicable, native skeletons, and especially skulls, should be sent home for accurate examination. Some tribes do not object to the removal of bones, especially if not of their own kinsfolk; in other districts it is hardly safe to risk displeasure at the removal of the dead—a feeling which is not only due to affection or respect, but even more to terror of the vengeance of the ghosts whose relics have been disturbed.

In describing complexion, such terms as "brown" or "olive" are too inexact to be of use. Broca's scale of colours (see Final Report of British Association Committee on Anthropometric Method. R. Anthrop. Institute, 1909) gives means of matching the tints of skin, hair and eyes; if this is not available, the paint-box should be

used. The colour of the skin is often so masked by paint and dirt that the subject must be washed to see the real complexion. Hair is an important race-mark, varying in colour from flaxen to black, and in form and size of the hairs; the American Indian's coarse straight hair seems almost like a horse's tail in comparison with the Bushman's hair with its natural frizz of tiny spirals. The traveller will often find difficulty in getting specimens, from objection to letting any part of the body, such as hair and nail-clippings, pass into strangers' hands lest they should be used to bewitch their former owner.

TEMPERAMENT

Differences of temperament are common: compare the shy and grave Malays with the boisterous Africans. It is an interesting but difficult problem how far such differences are due to inherited race-character, and how far to education and custom, and to the conditions of life. Nor has it been determined how far emotions are differently expressed by different races; notice if their smiling, laughing, frowning, weeping, blushing, etc., differ perceptibly from ours. The acuteness of sight, hearing, and smell, among wild peoples is often remarkable, but many accounts require sifting. The skill of savages in path-finding and tracking depends in great measure on this being one of the most necessary arts of life to which they are trained from childhood. The native hunter or guide's methods of following the track of an animal, or finding his own way home by slight signs, such as bent twigs, and keeping general direction through the forest by the sky and the sheltered sides of the trees, when learnt, lose much of their marvellous appearance. Testing the mental powers of races is interesting; some races are inferior to others in volume and complexity of brain, Australians and Africans being in this respect below Europeans, and the question is to determine what differences of mind may correspond. To compare the capacity of two races is made difficult by their different training. One of the best tests is the progress made by children in colonial or missionary schools; it is commonly stated that children of African or American tribes learn as fast as or faster than European children up to about twelve, but then fall behind. The subject is of great importance, both scientifically and as bearing on practical government.

RACE AND CLIMATE

The suitability of races to particular climates sometimes depends on one race being free from a disease from which another suffers, as in the immunity of negroes from yellow fever. Or tribes have become acclimatized, so as to resist influences which are deadly to strangers;

for instance, the Khonds flourish in the hills of Orissa, where not only Europeans but the Hindus of the plains sicken of malaria. That such peculiarities of constitution are inherited is one of the keys to the obscure problem of the origins of the races of man and their spread over the globe. No pains should be spared to get at facts thus bearing on the history and development of the human species. European medical men in uncivilized districts have often made important observations, which they are glad to communicate, though being occupied with professional work they do not follow them up. In all races there occur abnormal varieties, which should be observed, such as Albinos, whose dead-whiteness is due to absence of pigment from the skin. Even the occurrence of red hair where the ordinary hue is black, or melanism or diseased darkening of the skin, are worth remark. It is essential to discover how far these descend from parents to children.

LANGUAGE

The natural communication of all races by pantomimic signs without spoken words is the "gesture language" to which we are accustomed among the deaf-and-dumb, and which sometimes also comes into practical use between tribes ignorant of one another's languages, as on the American prairies. It is so far the same in principle everywhere, that the explorer soon adapts himself to the signs in vogue. As to most common signs, such as asking for food or drink, or beckoning or warning off a stranger, he understands and is understood quite naturally. Signs which are puzzling at first sight will prove on examination to be intelligible. Some are imitative gestures cut short to save trouble, or they may have a meaning which was once evident, like the American Indian sign for dog, made by trailing two forked fingers, which does not show its meaning now, but did so in past times, when one of the principal occupations of the dog was to trail a pair of tent-poles attached to his back. Besides its practical use, the gesture-language has scientific interest from the perfect way in which it exposes the working of the mind, by a series of steps which are all intelligible. It has a strict syntax; the quality or adjective must always follow the subject or substantive it is applied to. Thus, "the white box" may be expressed by imitating the shape and opening of a box, and then touching a piece of linen or paper to show its colour; but if the signs be put in the contrary order, as in the English words, the native will be perplexed. Where gesture-language is regularly used, note the usual signs and their exact order.

In recording a vocabulary of a language not yet reduced to form in a grammar and dictionary, the traveller may seek equivalents of the principal classes of words in his own grammar: verbs, substantives,

adjectives, pronouns, prepositions, etc. But the structure of the language will probably differ from any familiar, the words actually used not coming precisely into these classes. Learn a simple sentence, such as "the men are coming," and ascertain what changes will convert them into "the men are going," "the women are coming." He thus arrives at the real elements of the language and the method of combining them. Having arrived at this point, he will be able to collect and classify current ideas, such as the following:

Actions—as stand, walk, sleep, eat, see, make, etc.

Natural Objects and Elements—as sun, moon, star, mountain, river, fire, water, etc.

Man and other Animals—as man, woman, boy, girl, deer, buck, doe, eagle, eagles, etc.

Parts of Body—as head, arm, leg, skin, bone, blood, etc.

Trees and Plants.

Numerals (noticing how far they extend, and whether referring to fingers).

Instruments and Appliances—as spear, bow, hatchet, needle, pot, boat, cord, house, roof, etc.

Arts and Pastimes—as picture, paint, carving, statue, song, dance, toy, game, riddle, etc.

Family Relationships (as defined by native custom).

Social and Legal Terms—as chief, freeman, slave, witness, punishment, fine, etc.

Religious Terms—as soul, spirit, dream, vision, sacrifice, penance, etc.

Moral Terms—as truth, falsehood, kindness, treachery, love, etc.

Abstract Terms, relating to time, space, colour, shape, power, cause, etc.

Note the interjections used, whether they are organic expressions of emotion, like *oh! ugh! ur-r-r!* or sounds the nature of which is not so evident. Imitative words which name animals from their cries, or express sounding objects or actions by their sounds, are common in all languages: *kah-kah* for a crow, *twonk* for a frog, *pututu* for a shell-trumpet, *haitschu* for to sneeze. When such imitative words pass into other meanings where the connection with sound is not obvious, they become interesting facts in the development of language; as, to take a familiar example from English, the imitative verb to *puff* becomes a term for light pastry and metaphorically blown-up praise.

Only close acquaintance with a tribe can deal with the vocabulary and structure of their language. Conversation in broken sentences is not enough, for an actual grammar and dictionary is required to make out the structure and affinities with other languages. Lists of thirty or forty ordinary words cannot be said to be quite worthless, but they

go hardly any way toward what is really wanted. They are liable to frequent mistakes, as when the barbarian, from whom the white man is trying to get the term "foot," answers with a word meaning "my leg," which is carefully taken down and printed. Such poor vocabularies cannot even be relied on to show whether a language belongs to a particular family, for the very word which seems to prove this may be borrowed. Thus, in various African vocabularies, there appears the word *sapun* (or something similar) with the meaning of *soap*; but this is a Latin word which has spread far and wide. While it is best not to under-rate the difficulty of collecting information really of service to philology, remember that travellers have opportunities of preserving relics of languages, or at any rate special dialects, which are on the point of dying out unrecorded. Where no proper grammar and dictionary has been compiled, one may find some European or some interpreter, with whose aid a vocabulary may be written out and sentences analysed grammatically, which, when read over to intelligent natives and criticized by them, may be worked into good linguistic material. Pay attention to native names of plants, minerals, etc., as well as of places and persons, for these often carry significant meaning. Thus *ipecacuanha* is stated by Martius to be *i-pe-caa-guéne*, which in the Tupi language of Brazil, signifies "the little wayside plant which makes vomit."

ARTS AND SCIENCES

Stone hatchets, knives, arrow-heads, etc., such as in Europe are relics of ancient tribes, are not the oldest relics of the kind, but called neolithic or of the New-Stone Age, to distinguish them from the far older and lower types of the mammoth period, called palaeolithic or of the Old-Stone Age. Implements of this latter class, after their discovery in Europe, were soon noticed in India, and are now especially found over a great part of Africa. In the islands of the South Pacific, stone implements of an even lower class have not only been found in the ground, but there is evidence that they had remained in use into modern times. In Tasmania tools made from chips of hard stone by trimming to an edge on one side, and grasped in the hand without any handle, were the cutting and hacking instruments of the natives, almost up to the time of their extinction. Thus apparently the oldest known phase of human life endured in this region untouched by civilization, and travellers have the opportunity of studying its recent relics in Tasmania, while similar traces of rude Stone Age life, though not reaching up to so late a time, appear both in West Australia and New Zealand. Be careful to consider whether chipping is really artificial, and not due to natural causes. There is no doubt that many

implements in our museums are freaks of nature, *e.g.* some of those found in such quantities in the desert plateaux above the lower Nile.

The less civilized a nation is, the ruder are its tools and contrivances; but these are often worked with curious skill in getting excellent results with the roughest means. Stone implements are not easily found in actual use. If a chance occurs, as among some Californian tribe, who still chip out arrow-heads of obsidian, get a lesson in the curious and difficult art of stone-implement making. In general, tools and implements differing from those of the civilized world, even down to the pointed stick for root-digging and planting, are worth collecting, and to learn from a skilled hand the use of cudgel or boomerang-like weapons thrown at game, slings or spear-throwers for hurling darts to greater distances than they can be sent by hand, blow-tubes for killing birds, and even the bow-and-arrow, which in northern Asia and America shows the ancient Scythian or Tartar form, having to be bent inside out to string it. Some people still know the primitive method of fire-making by rubbing or drilling a pointed stick into another piece of wood. Europeans find difficulty in learning this old art, which requires some knack.

Special devices for netting, trapping and other ways of taking game and fish, are worth notice, such as spearing or shooting fish under water, artificial decoys, and the spring-traps set with bent boughs, which are supposed to have first suggested the idea of the bow. While the use of dogs in hunting is found in most parts of the world, there is the utmost variety of breeds and training. Agriculture in its lower stages is carried on by simple processes; but interesting questions arise as to the origin of its grain and fruits, and the alterations in them by transplanting into a new climate and by ages of cultivation. Thus in Chile there is found wild what botanists consider the original potato; but while maize was a staple of both Americas at the time of Columbus, its original form has no more been identified than that of wheat in the Old World. The cookery of all nations is in principle known to the civilized European; but there are special preparations to notice, such as bucaning or drying meat on a hurdle above a slow fire, broiling kebabs or morsels of meat on the skewer in the East, etc. Many peoples have something peculiar in the way of beverages, such as the chewed Polynesian *kava*. Especially fermented liquors have great variety, such as the *kumiss* from mares' milk in Tartary, and the *pombe* or millet-beer of Africa. The rudest pottery made by hand, not thrown on the wheel, is less and less often met with, but ornamentation traceable to its being moulded on baskets is to be seen; and calabashes, joints of bamboo, and close-plaited baskets are used for water-vessels, and even to boil in. Among the curious processes of

metal-working, often showing skill of their own, are the simple African smelting-forge by which iron-ore is reduced with charcoal in a hole in the ground, the draught being supplied by a pair of skins for bellows. In the Far East a kind of air-pump is used, of which the barrels are hollowed logs. The Chinese art of patching cast-iron with melted metal surprises a European, and the Hindu manufacture of native steel (*wootz*) is a remarkable process. No nation now exists absolutely in the Bronze Age, but this alloy still occupies something of its old place in Oriental industry. The Burmese bell-founding is done, not in a hollow mould of sand, but by what in Europe is called the *cire perdue* process, the model of the bell being made in bees-wax and embedded in the sand-mould, the wax being melted and the hot metal taking its place. The whole history of machinery is open to the traveller, who still meets with every stage of its development. He sees every tilling implement from the stake with fire-hardened point, and the hoe of crooked branch, to the modern forms of plough. He can trace the line from the rudest stone-crushers or rubbers for grinding seed or grain up to the rotating hand-mills or querns still common in the East. Some special contrivance may be seen near its original home, as in South America the curious plaited tube for wringing out the juice from cassava, or the net hammock which still retains its native Haitian name *hamaca*. Architecture still preserves interesting early stages of development, from the rudest breakwinds, or beehive huts of wattled boughs, up to houses of logs and hewn timber, structures of mud and adobes, and masonry of rough or hewn stone. Even the construction of the bough-hut or the log-house often has its peculiarities in the arrangements of posts and rafters. Among the modes of construction which interest the student of architectural history is building with rough unhewn stones. Many examples of "rude stone monuments" are to be seen on our own moors and hills. The most familiar kinds are *dolmens* (*i.e.* "table-stones"), formed by upright stones bearing a cap-stone; they were burial-places, and analogous to the cists or chambers of rough slabs within burial-mounds. Less clearly explicable are the single standing-stones or *menhirs* (*i.e.* "long-stones"), and the circles of stones or *cromlechs*. Ancient and obscure in meaning as such monuments are in Europe, there are regions where their construction or use comes down to modern times, especially where among certain tribes the deposit of ashes of the dead in dolmens, the erection of menhirs in memory of great men, and even sacrifice in stone circles, are well-known customs. One may also sometimes observe the ancient construction by fitting many-sided stones into Cyclopean walls, which seems to have preceded the use of squared blocks, fastened together with clamps or with mortar. Vaulting or roofing by courses of stones

projecting inwards one course above the other to form what architects call a "false arch," is an ancient mode of construction. It often appears that rude nations have copied the more artistic buildings of higher neighbours, or inherited ancient architectural traditions. Thus traces of Indian architecture have found their way into the islands of the Eastern Archipelago, and hollow squares of mud-built houses round a courtyard in northern Africa have their plan from the Asiatic caravanserai. In boat-building some primitive forms, as the "dug-out," hollowed by the aid of fire from a tree-trunk, and the bark-canoe, are found in such distant regions that we cannot guess where they had their origin. But the outrigger-canoe belongs to a district which, though very large, is still limited, so that we may at least guess whereabouts it first came into use, and it is important to note every island to which it has since travelled. So there is much in the peculiar build and rig of Malay prahus, Chinese junks, etc., which is worth noting as part of the history of ship-building.

Nations below the upper levels of culture have little or no science, but many of their ideas mark stages in the history of the human mind. Thus, in the art of counting, the primitive method of counting by fingers and toes is still in use, from which in many languages the numeral words have evidently grown. Thus *lima*, the well-known Polynesian word for five, meant "hand," before it passed into a numeral. All devices for counting are worth notice, from the African little sticks for units and larger sticks for tens, up to the ball-frames with which Chinese traders reckon so rapidly and correctly. It is a sign of lowness in a tribe not to use measures and weights, and where these appear in a rough way, it is interesting to discover whether vague lengths, such as finger, foot, pace, are used, or whether standard measures and weights have come in. If so, these should be measured by our standards to ascertain their history. In connection with this comes the question of money, whether commerce is still in the rudimentary stage of exchanging gifts, or has passed into regular barter, or risen to trade with some sort of money to represent value, even if the circulating medium be only cowries, or bits of iron, or cakes of salt, all which are current money to this day. Primitive ideas of astronomy and geography will be found: the obvious view, that the earth is a flat round disc (or sometimes square, with four quarters or winds) overarched by a solid dome or firmament, on which the sun and moon travel—in inland countries going in and out at holes or doors on the horizon, or, if the sea bounds the view, rising from and plunging into its waves at sunrise and sunset. With these ideas are found the two natural periods of time, the lunar month and the solar year, determined by recurring winters, summers, or rainy seasons.

Some tribes divide the day roughly by the sun's height in the sky, but often there is a tolerably accurate knowledge of the sun's place at the longest and shortest days, and indeed throughout the year. There is still a great deal unrecorded as to the constellations into which they map out the heavens. This likening stars and star-groups to animals and other objects is almost universal. Savages like the Australians make fanciful stories about them, as that Castor and Pollux are two native hunters, who pursue the kangaroo (Capella) and kill him at the beginning of the hot season. Such stories enable us to understand the myths of the Classical Dictionary. As to maps, even low tribes have some notion of their principle, and can roughly draw the chart of their own district, which they should be encouraged to do. Native knowledge of natural history differs from much of their rude science in its quality, often being of great positive value. The savage or barbarian hunter knows the animals of his own region and their habits with remarkable accuracy, and inherited experience has taught him that certain plants have industrial and medicinal uses. Thus, in South America the Europeans learnt the use of India-rubber or caoutchouc, which the native tribes were accustomed to make into vessels and playing-balls, and of the Peruvian bark or cinchona, which was already given to patients in fever.

Magic, so utterly futile in practice, is a sort of early and unsuccessful attempt at science. It is easy, on looking into the proceedings of the magician, to see that many of them are merely attempts to work by false analogy or deceptive association of ideas. The attempt to hurt or kill a person by cutting or piercing a rude picture or image representing him, is a perfect example of the way in which sorcerers mistake mere association of ideas for real cause and effect. From this point of view, a large proportion of the magic rites of the world will explain their own meaning. It is true that this is not the only principle at work in the magician's mind; for instance, he seems to reason in a loose way that any extraordinary thing will produce any extraordinary effect, so that the peculiar stones and bits of wood which we should call curiosities become to the African sorcerer powerful fetishes. Arts belonging to the systematic magic of the civilized world, which has its source in Babylon and Egypt, have found their way into distant lands more readily indeed than useful knowledge. Thus the system of lucky and unlucky days, which led the natives in Madagascar to kill many infants as of inauspicious birth, is adopted from Arabic magic, and it is to be expected that many other magical arts, if their formulae are accurately described, may in like manner be traced to their origin.

SOCIETY

One of the most interesting features of savage and barbaric life is the unwritten code of moral conduct, by which families and tribes are held together. There may be no laws to punish crime, and the local religion may no more concern itself directly with men's behaviour to one another than it did in the South Sea Islands. But among the roughest people there is family affection, and some degree of mutual help and trust, without which, indeed, it is obvious that society would break up, perhaps in general slaughter. Considering the importance of this primitive morality in the history of mankind, it is unfortunate that our information is often meagre as to how far family affection among rude tribes may be taken to be instinctive, like that of the lower animals, or how far morality is produced by public opinion favouring such conduct as is for the public good, but blaming acts which do harm to the tribe. It is desirable to inquire what conduct is sanctioned by custom among any people, whether, for instance, infanticide is thought right or wrong, what freedom of behaviour is approved in youths and girls, and so on. For though breaches of custom may not be actually punishable, custom acts in regulating their life even more strictly than among ourselves. The notion of savages leading a free and unrestrained life is contradicted by those who know them best; in fact, they are bound in every act by ancestral custom. While each tribe thus has its moral standard of right and wrong, this differs much in different tribes, and one must become intimately acquainted with any people to ascertain what are really their ruling principles of life. Accounts have been often given of the natural virtue and happiness where the simple life is marked by truthfulness, honesty, cheerfulness, and kindness. There are few phenomena more instructive than morality thus existing in practical independence either of law or religion. It may still be possible to observe it for a few years before it is altered by contact with civilization, which, whether it raises or lowers on the whole the native level, must supersede in great measure this simple family morality.

The unit of social life is the family, and the family is based on a marriage-law. Travellers who have not looked carefully into the social rules of tribes they were describing, or whose experience has been of tribes in a state of decay, have sometimes reported that marriage hardly existed. But this is not confirmed as descriptive of any healthy society, however rude; the absence of definite marriage appears incompatible with the continued existence of a tribe. Therefore statements of this kind should be carefully sifted, and marriage-laws in general deserve careful study. The explorer will hardly meet with marriage at so low a stage that the union can be described as little

beyond annual pairing; but where divorce is almost unrestricted, as in some African tribes, there is more or less approach to this condition. Polygamy is a well-understood system, but information is less complete as to the reasons which have here and there led to its opposite polyandry, as among the Toda hill-tribes. Among customs deserving inquiry are match-making festivals at springtide or harvest, when a great part of the year's marriages are arranged. The custom of bride-capture, where the bridegroom and his friends make show of carrying off the bride by violence, is known in Europe as a relic of antiquity; in more barbaric regions, as on the Malay peninsula or among the Kalmuks of North Asia, it may be often met with, practised as a ceremony, or even done in earnest. Restrictions on marriage between kinsfolk or clansfolk are more prominent among the lower races than in the civilized world, but their motive is imperfectly understood. Partly these restrictions take the form of prohibiting marriage between relatives more or less near in our sense, but among nations at a lower level they are apt to involve exogamy or "marrying-out." A tribe or people—for instance, the Kamilaroi of Australia—is divided into hereditary clans, members of which may not marry in their own clan. These clans may be named from some animal, plant, or other object, and anthropologists often call such names "totems," from the native name among Algonquin tribes of North America. Among the Iroquois tribes a Wolf was considered brother to a Wolf of any other tribe, and might not marry a Wolf girl, who was considered as his sister, but he might marry a Deer or a Heron. In contrast with such rules is the practice of endogamy, or "marrying-in," as among some Arab tribes, who habitually marry cousins. But the two rules often go together, as where a Hindu must practically marry within his own caste, but is prohibited from marrying in his own gotra or clan. Researches into totem-laws are apt to bring the traveller into contact with other relics of the ancient social institutions in which these laws are rooted, especially the practice of reckoning descent not on the father's side, but on the mother's, after the manner of the Lycians, whose custom seemed extraordinary to the Greeks in the time of Herodotus, but may be still seen among native tribes of America or in the Malay islands. Where forms of the "classificatory system" prevail, the father's brothers and mother's sisters are called fathers and mothers. In inquiring into native laws of marriage and descent, ensure accuracy, and especially avoid such ambiguous English words as "uncle" or "cousin."

Another opportunity of seeing the working of primitive society is in the holding and inheritance of property, especially land. In rude society it is very generally the tribe which owns a district as common

land, where all may hunt and pasture and cut fire-wood; while, when a family have built a hut, and tilled a patch of land round it, this is held in common by the family while they live there, but falls back into tribe-land if they cease to occupy it. This is further organized in what are now often called "village communities," where the village fields are portioned out among the villagers. The working of this old-world system throws light on projects of communistic division of land, which in such villages may be studied, and its merits and defects balanced. On the one hand it assures a maintenance for all, while on the other it limits the population of a district, the more so from the obstinate resistance which the council of "old men" who manage a village always oppose to any improved method of tillage. Not less perfectly do the tenures existing in many countries show the stages of land-holding which arise out of military conquest. The absolute ownership of all the land by a barbaric chief or king, whose subjects hold their lands on royal sufferance, is an extreme case. In the East, feudal tenures of land granted for military service still have much the same results as in mediaeval Europe.

At low levels of civilization the first dawning of criminal law may be seen in the rule of vengeance or retaliation. The person aggrieved, or his kinsfolk if he has been killed, are at once judges and executioners, and the vengeance they inflict stands in some reasonable relation to the offence committed. Not only is such vengeance the great means of keeping order among such rude tribes as the Australians, but even among half-civilized nations the primitive law may still be studied in force, carried out in strict legal order as a *lex talionis*, not degraded to mere illegal survival in outlying districts like the vendetta of modern Europe, carried on, in spite of criminal jurisprudence, which for ages has striven to transfer punishment from private hands to the State. Whether among savages, barbarians, or the lower civilized nations, the law and its administration may be still in the state of unwritten custom, and the council of old men may be the judges, or the power at once of lawgiver and judge may have passed into the hands of the chief, who, as among the modern Kaffirs, may make a handsome revenue by the cattle given him as fees by both sides, illustrating the times when an European judge took gifts as a matter of course. In the East most of the stages may still be seen through which the administration of law, criminal and civil, was given over to a trained legal class. One important stage in history is marked by religion taking to itself legal control over the conduct of a nation. The working of this is seen among Oriental nations, whether Muhammadan, Brahman, or Buddhist, whose codes of law are of ecclesiastical type, and the lawyers theologians. There is much to be learnt from the manner in which

such law is administered, and the devices are interesting by which codes framed under past conditions of society are practically accommodated to a new order of things, without professedly violating laws held to be sacred, and therefore unchangeable. Ordeals, which have now disappeared from legal procedure among European nations, are often to be met with elsewhere. Thus in Arabia the ordeal by touching or licking hot iron is still known: the latter an easy and harmless trick, if the iron is quite white-hot. In Burma, under native rule, the ancient trial of witches by "swimming" went on till lately. In many countries symbolic oaths invoking evils on the perjurer are to be met with, as when the Ostyaks in Siberia swear in court by laying their hand on a bear's head, meaning that a bear will kill them if they lie.

The most undeveloped forms of government are only to be met with in a few outlying regions, where life goes on with hardly any rule beyond such control as the strong man may have over his own household. Much oftener travellers have opportunity of studying, in a more or less crude state, the types of government which prevail in higher culture. It is of especial interest to see men of the whole tribe gathered in assembly (the primitive *agora*) to decide some question of war or migration. Not less instructive are the proceedings of the council of old men (the primitive *senate*), who, among American tribes or the hill tribes of India, transact the business of the tribe; they are represented at a later social stage by the village-elders of the Hindus. The patriarchal system still prevails among such tribes as the Badawin, while often the balance of power adjusts itself between the patriarchal heads of families and the leaders who obtain authority by success in war. The struggle between the hereditary chief or king and the military despot, who not only usurps his place but seeks to establish hereditary monarchy in his own line, is met from low to high levels of national life. But social forces do their work independently of men in authority, and make society possible, even when there is little visible authority at all. The machinery of government described in books is often much less really powerful than public opinion, which controls conduct in ways so much less conspicuous that they have hardly yet been investigated with the care they deserve.

RELIGION AND MYTHOLOGY

While great religions like Muhammadanism and Buddhism have been so carefully examined that European students often know more about their sacred books than the believers themselves, yet the general investigation of the religions of the world is very imperfect, and every effort should be made to save the details from being lost as one tribe after another disappears, or passes into a new belief. Missionaries

have done much in recording particulars of native religions, and some have had the skill to describe them scientifically; but the point of view of the missionary engaged in conversion to another faith is unfavourable for seeing the reasons of the beliefs and practices he is striving to upset. The object of the anthropologist is neither to attack nor defend doctrines, but to trace their rational origin and development. Religious ideas of a primitive order hold their place also among the higher nations who profess a Book-religion. Thus the English or German peasant retains many ideas belonging to the ancestral religion of Thor and Woden, and the modern Burmese, though a Buddhist, carries on much of the old worship of the spirits of the house and the forest, which belong to a far earlier religious stratum than Buddhism. All over the world people may be found whose conception of soul or spirit is that belonging to primitive animism, namely, that the life or soul of men, beasts, or things, resides in the phantoms of them seen in dreams and visions. A traveller in British Guiana had serious trouble with one of his Arawaks, who, having dreamed that another had spoken impudently to him, on waking up went quite naturally to his master to get the offender punished. So officials have considered themselves disrespectfully treated when the wife or servant of the person they have come to see has refused to wake him, believing the soul to be away from the sleeper's body in a dream, so that it might not find its way back if he were disturbed. These primitive conceptions have important bearing on the history of philosophy and religion. The same may be said of the ancient theory of diseases as caused by demons, and the expulsion and exorcism of them as a means of cure, which may still be studied everywhere outside the scientific nations. Information as to religious rites is valuable, even when the observer does not understand them, but if possible their exact meaning should be made out by some one acquainted with the language, otherwise acts may be confused which have really different senses, as where a morsel of food offered as a pious offering to an ancestral ghost may be taken for a sacrifice to appease an angry wood-demon. A people's idea as to the meaning of their own rites may often be very wrong, but it is always worth while to hear what they think of the purpose of their prayers, sacrifices, purifications, fasts, feasts, and other religious ordinances, which have been long since stereotyped into traditional systems.

Mythology is intimately mixed up with religion, which not only ascribes the events of the world to the action of spirits, demons, or gods, but everywhere individualizes many of these beings under personal names, and receives as sacred tradition wonder-tales about them. Thus, to understand the religion of some tribes, we have not only to consider the rude philosophy under which such objects as

heaven and earth or sun and moon are regarded as personal beings, whose souls (so to speak) are the heaven-god and earth-god, the sun-god and moon-god; but we have to go on further and collect the religious myths which have grown on to these superhuman beings. The tales which such a people tell of their origin and past history may to some extent include traditions of real events, but mostly they consist of myths, which are also worth collecting, as they often on examination disclose their origin, or part of it. This is seen, for instance, in the South Sea Island tale of the god Maui, whose death, when he plunged into the body of his great ancestress the Night, is an obvious myth of the sunset. The best advice is to write down all promising native stories, leaving it to future examination to decide which are worth publishing. The native names of personages in such stories should be inquired into, as they sometimes carry in themselves the explanation of the story itself, like the name of Great-Woman-Night in the Polynesian myth just referred to. Riddles are sometimes interesting, as being myths with an explanation attached, like the Greek riddle of the twelve black and twelve white horses that draw the chariot of the day. Everything which a people thinks worth remembering as a popular tradition, and all the more if it is fixed in rhyme or verse, is worth notice, as likely to contain something of historical value. That it may not be historically true is beside the question, for the poetic fictions of a tribe often throw more light on their history than their recollections of petty chiefs who quarrelled fifty years ago. The myths may record some old custom or keep up some old word that has died out of ordinary talk, or the very fact of their containing a story known elsewhere in the world may give a clue to forgotten intercourse by which it was learnt.

Though study of religion and folklore must be left to those who are residents rather than visitors, the passer-by who inquires may see primitive rites of religion or magic. In many an Indian house in Arizona or New Mexico the traveller is reminded of his classic recollections when he sees the first morsel of the meal thrown into the fire as an offering to the ancestral spirits.

CUSTOMS

Multifarious customs will come under the traveller's observation. These may be already described in books, but accurate examination in such matters is so new, that something always remains to be made out, especially as the motives of so many customs are still obscure. The practice of artificially deforming the infant's skull into a desired shape, which is not quite forgotten even in Europe, may be noticed with respect to the question whether the form to which the child's

head is bulged or flattened is the exaggeration of the natural form of an admired caste or race. If not, what can, for instance, have induced two British Columbian tribes, one to flatten their foreheads and the other to mould them up to a peak? In tattooing, an even more wide-spread practice, ascertain whether the pattern on the skin seems to have been originally tribe-marks or other signs or records, or whether the purpose is ornament. In South-East Asia the two motives are present at once, when a man has ornamental designs and magical charm-figures together on his body. With regard to ornaments and costumes, the keeping-up of ancient patterns for ceremonial purposes often affords curious historical hints. Thus in the Eastern Archipelago the old-fashioned garments of bark-cloth are used in mourning by people who have long discarded them in ordinary wear; among some natives of South India, the women, though they no longer put on an apron of leaves as their ordinary garment, wear it over a cotton skirt on festival-days. Among the amusements of a people, songs are often interesting musically, not only for the tunes, but for the words, which sometimes throw light on old traditions and beliefs. Dancing varies from spontaneous expression of emotion to complex figures handed down by tradition and forming part of social and religious ceremony. The number of popular games in the world is smaller than would be supposed. When really attractive they may be adopted from one people to another. Any special variety, as of ball or draughts, may furnish evidence of intercourse with some distant nation.

In taking notes, do not be afraid of tedious minuteness; the lively superficiality of popular books of travel makes them almost worthless for anthropology.

QUERIES OF ANTHROPOLOGY. *By the late* Sir A. W. Franks

Physical Character

Average height of men and women in each tribe. Character of hair: straight, wavy, curly, frizzy, or woolly. Prognathism. Strength in lifting and carrying weights, etc. Speed in running. Accuracy of aim. Knowledge of numbers, weights, and measures.

Mode of Subsistence

Whether mainly by hunting, or by pastoral or agricultural pursuits. Any instances of dwellings in caves.

Use of boats; forms of boats and of paddles; mode of paddling.

Any particular stratagems used in hunting, snares and traps; implements for hunting; use of dogs and of cross-bows, as well as bows and arrows.

Fishing; nets; fish-hooks; spears; any javelins or arrows with loose heads attached by a cord.

Modes of cooking, and implements used; any particular observances in cooking or at meals; any separation of sexes at meals. How is fire produced? and are any persons charged with the preservation of it?

Forms and construction of houses. Separation of the sexes.

Furniture of houses.

Plans of towns and fortifications.

Plants cultivated for food or manufactures; agricultural implements

Religion and Customs

Birth ceremonies.

What are the idols and their names? Is there any distinction between them in importance? What worship is paid to them? and what offerings are made, and on what occasions?

Are there any particular superstitions? What fetishes or amulets are used? by whom are they made? Are there any forms of divination, any use of casting lots with cowries, ordeals by poison or otherwise?

Vampire beliefs and ghost beliefs generally.

Cannibalism, and motives for the same.

Funeral rites. Belief in a future state. Deposit of objects with the dead, and whether deposited broken or whole, in or on the grave.

Are burial customs associated with belief in destiny after death?

It is important that the traveller should distinguish between genuine native traditions and those acquired through contact with civilized peoples.

Peace survivals among newer peoples.

Arts and Manufactures

Mode of spinning and weaving; patterns and materials employed.

Dyeing and nature of dyes.

Any mode of preparing and working leather.

Any knowledge of glass-making. If not acquainted with the manufacture of glass, do they melt down broken European glass and beads to make armlets and other ornaments?

Musical instruments: their forms, nature, and names.

Knowledge of pottery and mode of manufacture.

Use and manufacture of tobacco and other narcotics; forms of tobacco-pipes; any ceremonies connected with smoking; use of snuff; snuff bottles.

Manufacture and trade in salt, wine, beer, or other liquors.

Knowledge of simple medical remedies, cupping, etc.

Ivory and wood-carving.

Metallurgy: working in the various metals, whether by a special class of people or tribes; implements used in smelting, etc. Where are the ores obtained?

Is there any knowledge of precious stones?

Personal Ornaments, Disfigurements, etc.

Are there any special marks made by tattooing or cicatrices to distinguish the various tribes? are they the same in both sexes? Drawings of these marks would be very desirable, distinguishing each tribe.

Are the teeth filed or knocked out? If the former, into what shapes are they filed? when is the filing effected? and is it the same for both sexes?

Is antimony used for the eyelids? and how is it applied?

Are ear-ornaments worn by either sex? are they pendent or inserted in the lobe? Are there any nose or lip ornaments?

Is the hair cut into any peculiar shape, or is its colour altered by dyeing?

Is any cap or protection worn on the penis, as by the Kafirs and other tribes?

Any peculiarities of dress for men and women? any distinction between married and unmarried?

What protection is worn in battle? What are the forms of the weapons? and is any missile weapon in use?

Is there any mutilation of the sex organs?

Are any marks used as distinctions for bravery, success in hunting or rank?

Ivory and Wood Carving

If elephant ivory is not of native origin, where is it obtained? Are any other materials of the same nature employed in carving, such as walrus-tusk, cachalot teeth, etc.? Are any very hard woods employed; and if so, how are they worked?

Money

What kinds of money are in use? Do the coins pass by weight as bullion, or have they a recognized value? Are any objects such as iron bars or tools, salt, pieces of cotton, cowries, beads, wampum, etc., employed as a means of exchange? If so employed, is there any recognized way in which their value is certified, or is their value the subject of bargain in each case?

CHAPTER XIX. ANTIQUITIES

The following notes are based upon the chapter in the last edition of this book written by the late Dr. Hogarth.

Travellers without special knowledge who find antiquities probably unrecorded or unpublished may usefully record them (*a*) by photography, moulding, or rubbing; (*b*) by planning or drawing; (*c*) by measurement and description.

RECORDING

Inscriptions which are worn or in material with superficial faults do not photograph well, and if on dark material must often be prepared with white chalk before being photographed: better than employing moulding.

Photographs of sculpture should be as large as possible and from many points of view. Improve light and relief by arranging reflected light from tin or white paper. To improve contrast on worn or broken sculpture one may dust with powdery sand and carefully fan it, which leaves hollows and backgrounds in strong contrast to the surface. Highly polished surfaces may be dulled. Metal is difficult. It is better to make casts of coins and if necessary photograph them. Make careful notes of colouring. Small objects are best photographed on a sheet of glass raised a foot above the ground, the camera pointing vertically downwards.

Moulding will generally be done with paper, of which any fairly strong unsized paper will serve more or less well. Other implements are a sponge, two or three close-bristled not very hard brushes, preferably with hand straps on the back or curved handles, though clothes brush, nail brush, and tooth brush will serve.

Brush and clean an inscribed stone, and pick accumulation of dirt out of the letters; then wet it thoroughly. Lay the dry paper out to size as flat as possible and dab it down with the sponge very wet; take the largest brush and pound the paper gently all over till it partially adheres, then work it into depressions with the smaller brushes and all the pressure you can use; finally hammer it again with the large brush from top to bottom or side to side to drive out air bubbles. Where the stone has come through the paper lay on a second sheet

and treat as the first. Leave the sheets to dry on the stone and all will come off together as a perfect reverse impression.

If, owing to shape of stone or size, work must be done in sections, make the edges overlap so that later all can be joined. Number the sheets according to a plan in the notebook and mark the lines of junction on the sheets themselves. Peel off superfluous edges as apt to lift in the wind. If the paper cannot be left to dry in place peel off carefully and lay out reverse side uppermost. When dry roll the squeeze inside a tin cylinder.

Moulding sculpture is much more difficult. For a full account of moulding Maya monuments up to 25 feet high, see Mr. A. P. Maudslay's instructions in previous editions of this book.

Rubbing is possible only on a smooth surface and has nothing to recommend it except the ease and speed with which it can be done. Heel-ball and thin tough paper only are required.

Planning a ruin field by survey with tape, tacheometer, or theodolite must be done by adopting the methods of Volume I.

An inscription should always be copied as well as photographed or moulded, particularly because the copy has a better chance of surviving the accidents of travelling, but also because if the surface is at all perished a keen eye and power of concentration will see more lettering than the photograph or squeeze will show. Make the copy on paper ruled in squares as nearly to scale as possible. Scrupulously copy all broken parts of letters. They can often be distinguished from flaws in the stone by feeling along the groove with a knife blade; if the line is even the groove is probably part of a letter. Measure all intervals where letters have perished and so estimate the number of lost letters; indicate by dots in shaded patches. Indicate uncertainty by dotting or drawing faint. If the stone is imperfect but its original breadth can be estimated, mark the central line on the copy to guide the restorer of the text. Draw all letters with peculiar forms at least once, as specimens. Show the relation of the text to any sculpture. Look for and note marks of punctuation or division, ligatures, and ornamented initials and finials. Transcribe first the easy parts of the inscription. When copy is finished try to translate it and reconsider the harder parts of the inscription. Stones with two inscriptions one over the other must be moulded, for an untrained copyist will find it very difficult to draw an accurate copy.

Record material, colour, dimensions, condition of preservation,

arrangement of parts, and character of ornament. Dimensions of buildings are especially important since photography can seldom cover the whole, and there may be no opportunity for a complete plan. For inscriptions record form of the stone, condition of surface, material, and colour, on what sides flat and what not, dimensions, height of lettering, character of lettering, whether well or ill cut, plain or ornamented. For coins record material, ancient value, weight, preservation, images, and superscriptions. For sculpture: material, dimensions, degree of finish, and minute analysis of the subject, dress, gestures, attributes, etc.

"It was Almásy who found the first of these caves and showed it to Professor Ludovico di Caporiacco, of the Italian mission, and to me. Two hours later about a dozen more of these caves were located, all covered with beautiful rock paintings in four colours, showing cattle and other animals, mostly tame ones, and human beings: dark-skinned warriors with bows in their hands, with many ornaments and with plumes in their hair. The most interesting picture represented the cave itself, surrounded by a circle of granite boulders, and in it an interesting pair: a slender man and an enormous lady—evidently Monsieur and Madame, the owners of this cave, who had decorated their home with their portraits. Near the caves Dr. Kádár collected many Stone Age implements." *Bermann. 'Uweinat.* 83.461.

"I sent the coins which we had found to the British Museum. The authorities there were extremely interested in them, saying that, though some of them were fairly well known and only one or two rare, no similar coins had been previously discovered on the East African coast, so far as they knew. They very kindly identified many for me, and I have most of them now. Their number and variety showed that the ruins must have been once a long-established trading centre, for there were coins of Ptolemy III, IV, and V, third and first century B.C.; Roman coins (Alexandria) of Nero, Trajan, Hadrian, and Antoninus Pius, Maximin, Antioch, and Constantinople; as well as many of Constantine XI and XII, together with Mamelukes of Egypt, and Egypt under the Turks." *Haywood. Somaliland.* 85.64.

CLEANING AND PRESERVATION

Objects must perhaps be cleaned to show their true character and consolidated for safe transport, but do as little as possible, leaving treatment to museum experts. Gold requires no immediate treatment. If it is laid over a core of copper or bronze which has oxidized out through cracks, the oxide may be picked off. Corroded silver should be left alone. Pack always in wood or cardboard, never in tin boxes, which produce corrosion. Bronze and copper may have heavy corrosion flaked off, then rub well with oil in the palm of the hand. Lead and iron after oiling should be left alone.

Small objects of stone or marble attacked by salt should be soaked long in water and laid to dry with the principal surface downwards so that evaporation takes place through the less important surfaces. Pottery and terracotta may be freed from salt in the same way. Pack in cases with partitions, and fill large vases tightly. Never pack heavier things with pottery.

Wood, ivory, and bone generally need consolidation. Consider binding in every direction and part with fine thread to keep the object from splitting, or if already split, to prevent falling apart and splintering or warping. If not too tender, dip in melted vaseline, let it set, wrap in tissue paper, and pack in cotton-wool. If objects very tender or rotten with salt, make a stiff jelly, drop them in before it sets, and convey them home in aspic. On the way the jelly will absorb the salt. Do not attempt to deal with crystalline carbonate of lime.

Papyrus whose edges are brittle may need damping and flattening without breaking the fibre. Lay between two damp towels, pack between two sheets of paper in boxes, filling each tightly but do not try too much, and if edge is not brittle, best pack carefully without unrolling. Amber and compositions should never be treated. Leave flaking glass wholly alone. Other objects may, if flaky or powdery, be dipped in melted vaseline.

In the last edition Dr. Hogarth gave also instructions for using chisels and burins upon metal objects and treating both them and stone with acid. We are advised that any treatment with hydrochloric acid by some one not skilled would almost certainly do more harm than good, and that in general specimens collected should be treated as little as possible, preservation and not preparation for study being all that is necessary in the field.

Small objects may be moulded in plaster of Paris if procurable. Mix just as much plaster as will absorb the water leaving none free on top. Clean the object well and soap it. Apply plaster very rapidly in a thin coat all over the object at once; back with more plaster afterwards. Mould a large surface in sections or lay strings upon the object before moulding and pull them up from the plaster while yet viscous.

If sealing wax is used, never heat it in contact with flame. Hold a card over a lamp or spirit burner and rub wax upon the upper surface till enough has melted in without boiling.

Obtain useful impressions of coins and gems by pressing ordinary tinfoil upon them. Float the impressed foil on water face downwards and drop wax upon it to solidify.

Collect potsherds from all sites likely to be unrecorded, numbering them in pencil or pencilling on them the locality.

Remember that unskilled digging, though it may produce interesting objects, destroys too often essential evidence of period. The unskilled should be content to collect what is on the surface, and to make careful notes of indications for the future use of experts.

"The Middle Ages are out of fashion at the present moment with archaeologists in the Near East, and the importance of prehistoric discoveries leaves little interest over for buried Islamic cities. By the time that such an interest may be expected to revive, one of the chief monuments of the early twelfth century in Persia will only too probably have been destroyed for ever. This is the minaret of Saveh (about 80 miles south-west of Tehran), built of and decorated from top to bottom with burnt bricks in a delicate tracery of geometric patterns and Cufic script. . . .

The outline of the walls of the old town can still be seen under the ground, far beyond the present area of habitation; and the inhabitants spent their time for many years digging shallow holes into the site and obtaining exquisite pottery which they sold to a 'Mr. Noah (?) from Paris,' who dealt in antiques. This destructive traffic has happily been stopped by the present Persian laws of export: when I visited the town, a number of these relics were still about, dug up before the knowledge came that Mr. Noah's visits were to cease, and I bought them. The site has been a good deal spoilt by these diggings: but it is so large, and was so prosperous a city, that it would still well repay an excavator; and there is the great advantage that the ancient city is mostly outside the modern town, and has therefore been very little built over during the five centuries that followed its decay." *Freya Stark. Iran.* 85.69.

CHAPTER XX. HEALTH AND DISEASE

By Dr. G. Carmichael Low and C. B. Warren

This chapter is primarily for the traveller not a medical man by training. He is certain, sooner or later, to be called upon to treat illness in his party and among the native population. Only those measures which can safely be undertaken by those not qualified to practise medicine have been included in the sections on treatment, though more elaborate methods have been indicated without further comment than to say that medical aid must be called in. A medical man travelling with the party will not require these "hints"; he will select for himself his medical library, but may find the list of equipment useful.

Submit to a medical examination before setting out, as in this way only will a latent weakness be revealed.

Make a point of acquiring a working knowledge of anatomy and the common medical and surgical diseases. Learn

1. To take the body temperature.
2. To use the hypodermic syringe, the stomach tube, and the drugs in the medicine chest.
3. To stop bleeding from a wound or cut vessel.
4. To dress a wound according to aseptic principles.
5. To set the common types of dislocation of a limb.
6. To splint the common types of fracture.
7. To treat burns and scalds.
8. To treat snake bites.

To gain knowledge on these and other points attend a course of ambulance lectures, or talk to a medical friend, show him the list of drugs to be taken, and learn the uses and dosage of each and how they should be administered.

In England there are excellent schools of Tropical Medicine in several cities, usually willing to give advice where it is wanted.

Some tropical diseases are limited to particular countries and districts; therefore find out before starting what diseases one is most likely to encounter, and add special drugs to the equipment, which might not otherwise be necessary. The following table may be useful:

Beriberi occurs in Federated Malay States, Dutch East Indies.

Bilharzia in Egypt, Transvaal, Rhodesia, West Coast Africa, Brazil. Use antimony tartrate, Fouadin, emetine.

Blackwater fever in Central Africa, India: Duars Terai. Less common elsewhere but may occur wherever malaria does. Do not give quinine after blackwater has started.

Cholera in India and the East.

Dengue in tropics generally.

Dysentery in tropics and subtropics generally. For amoebic use emetine; for bacillary use sodium sulphate.

Enteric fever in tropics and subtropics generally.

Leishmaniasis (Kala-azar) in Mediterranean Basin, Sudan, India: Assam. Use antimony tartrate; pentavalent organic preparations of antimony; Neostibosan, etc.

Liver abscess in same places as amoebic dysentery. Use emetine.

Malaria in tropics and subtropics generally. Use quinine, Atebrin, Plasmoquine.

Myiasis from Tumbu fly: West Africa. Ver Macaque or mosquito worm: Central and South America. Screw worm: Central and South America.

Plague in India, and sometimes other places in the East. Use preventive inoculation.

Sandfly fever in Mediterranean Basin, India, Mesopotamia, Persia, etc.

Trypanosomiasis in Africa: Equatorial Africa, Rhodesia and Nyasaland. South America: Brazil. For African use Bayer 205, Tryparsamide.

Undulant fever in Mediterranean Basin, Red Sea and the East.

Yellow fever in Central America, northern parts of South America, West Africa.

PROPHYLACTIC INOCULATIONS

Smallpox, enteric fever, and cholera, commonly met with in the tropics, can be guarded against by inoculations.

1. Smallpox can be prevented by vaccination. Those not already vaccinated must have it done. When going to a tropical country re-vaccination is advisable every three years, so those not vaccinated quite recently should be done again.

2. Inoculation with T.A.B. vaccine gives some protection against Enteric (Typhoid) and reduces its severity if contracted. Two injections, and sometimes 3, given at intervals of a week to ten days, and several weeks before reaching the tropical country, since resist-

ance of the inoculated is slightly lowered for a short time after the injection.

3. Anti-Cholera Inoculation gives some protection, but immunity lasts only a short time and is not so complete as for enteric. Inoculation made a short time before going where cholera is prevalent. Two injections are necessary, the second one week after the first.

EXAMINATION OF NATIVE ATTENDANTS

Have all native attendants medically examined before starting in the tropics to exclude those suffering from venereal complaints; those harbouring intestinal parasites, worms, dysentery germs, etc.; and those with any severe constitutional disorder. If possible have their motions examined by an expert to see if they contain the eggs or segments of worms, or the amoebae and cysts of dysentery. An apparently healthy native may be a dysentery carrier and a serious menace.

TRANSMISSION OF INFECTION

Many of the commoner tropical diseases, cholera, dysentery, enteric, etc., are transmitted by infected drinking water, milk, improperly cooked food, and dirty crockery. Take special measures to avoid being infected from one of these sources. Wherever possible camp at some distance from a village. Boil all drinking water, milk, etc., and avoid native drinks. Food must be properly cooked, including vegetable foods. Make it a duty to see that these measures are carried out; it is not sufficient to be told by a native cook that they have been done. Make surprise raids on the kitchen; inspect all saucepans and cooking utensils at regular intervals to see that they are being kept clean.

A filter is important; that made by the Berkfeldt Filter Company has a small hand-pump which forces the water through a porcelain filter candle. The essential part is the candle; take one or two spares since they are easily broken in cleaning. A filter frees the thickest river water from mica and particles of contaminating matter, but should not be relied upon to free the water of germs, which can be destroyed with certainty only by boiling. Omit only in mountainous regions, above the level of human habitation.

Flies and insect pests carry infection of several diseases (*see* Insect

Pests). Remember that the housefly can carry the dysentery germs on its feet; protect food with muslin.

Avoid river bathing when the water is likely to be contaminated with the excrement of natives; there is risk of infection with dysentery, cholera, etc., through mouth and lips. Fresh-water bathing especially dangerous in Egypt and other parts where bilharzia is common.

Hook worm infection is extremely common in many tropical countries. The embryos are in the soil and enter the human host through the skin, usually through the soles of the feet. Do not go with bare feet in camp, or at any time.

CHILL

Excessive perspiration predisposes to chill. With a cool breeze, or sudden drop in temperature at night-fall, evaporation of the sweat will occur and cause excessive cooling. The resistance of the body to infection is then lowered and in the tropics stomach trouble may occur. This is frequent in India in those going up to the hill stations from hot plains and is known as "hill diarrhoea." Those infected with malaria are particularly liable to relapses in similar conditions.

Therefore see that damp or sweaty clothing is changed at the end of each day; avoid sudden changes of temperature, such as sitting in draughts, taking cold baths, and going up to the hills unsuitably clad; ensure that the abdomen is adequately protected at night.

DIET

Eat very moderately in tropical climates. Remember that fatty foods are heat-producing and should therefore be reduced in quantity. Avoid heavy meals particularly in the heat of the day; take the main meal always at night. Food should be sufficiently cooked, not only to make it digestible, but also to destroy parasites.

See also pages 72, 73, 75.

DIAGNOSIS

Often the true nature of an illness does not become obvious for several days. In obscure cases put the patient to bed and from the start record the temperature, pulse, and respiration rates at least twice daily. The records may be invaluable at a later date. Do not miss an opportunity of inspecting the urine, the motions, and phlegm which is coughed up, when the occasion arises.

Now proceed as follows: Examine body generally and note any rash. (See sections on infectious fevers and enteric.) Inspect the tongue and then the throat, at same time feeling in neck for swollen glands. Look at the chest and note whether breathing is altered or difficult. Examine the belly and groins for abnormal swellings or tenderness. Look at the limbs and note any rash, swollen joints or other abnormalities.

Fever which does not vary by more than $1\frac{1}{2}°$ F. in the 24 hours is *continuous*. When fluctuations exceed 2° F. but temperature never reaches normal, fever is *remittent*. When temperature falls to normal at least once a day it is *intermittent*.

Note relation between pulse frequency and fever; it should increase by about 8 beats per minute for each degree F. of fever. Continued fever with pulse frequency below 90 suggests typhoid. (See Enteric.) Note relation between respiration rate and fever; it should increase by about 3 respirations per minute for each degree F. of fever. Disproportionate increase suggests a respiratory affection. (See Bronchitis; Influenza; Pneumonia.) Regular intermittent fever suggests the presence of pus somewhere in the body; other symptoms, such as sore throat, may give a clue to the seat of trouble. (See Quinsy; Boils; Liver abscess.) Periodic intermittent fever, particularly in the tropics, should suggest malaria; note whether fever occurs every 48 hours (Tertian malaria) or 72 hours (Quartan malaria). In this disease the fever is generally preceded by shivering. (See Malaria; Blackwater-fever.)

Pain may be in the chest, in which case note its relation to the breathing. (See Pleurisy; Pneumonia; Fractured ribs.) When in the belly note its position and whether it radiates to other parts. Ask where pain commenced: Was it accompanied by vomiting, and if so which came first? Is the pain continuous, or does it come and go? Are the bowels constipated or loose; if the latter was there blood or slime with the motions? Is the flow of urine normal, or is there pain or burning? Then examine the belly and groins for tenderness or swellings, using light pressure only with the tips of the fingers. (See specially Appendicitis; Colic; Constipation; Cystitis; Diarrhoea; Dysentery; Enteric; Indigestion; Rupture.) The causes of pain in other situations are likely to be more obvious.

Headache is a prominent symptom at the onset of many fevers

but perhaps is particularly important in certain diseases. (See specially: Meningitis; Influenza; Smallpox; Concussion; Sunstroke.)

Vomiting occurs in many conditions, but when accompanied by pain in the belly ask which came first the pain or the vomiting. In appendicitis the pain always precedes vomiting; in less important conditions it often comes afterwards, but strangulated rupture is an exception to this rule. (See Appendicitis; Colic; Constipation; Indigestion; Rupture.)

Other symptoms. (See Colic; Constipation; Diarrhoea; Earache, etc.)

NURSING

Direct treatment of disease or injury may not be possible without medical aid, but much can be done for the patient to make him comfortable until help comes, or until he can be removed to a place where his disease can receive the proper attention. Therefore carefully attend to all details of nursing.

Taking the temperature

Wash the thermometer in an antiseptic solution for a few minutes and rinse in clean water. Place the thermometer in the mouth, the armpit, or the lower bowel. By mouth is the most reliable method. Place the bulb under the tongue and close the lips on the shaft. Leave in position for two minutes, then withdraw and read.

Or dry skin and place the bulb in the armpit; then press the arm against the body. Leave thermometer in position for five minutes. This method is best for natives. Or pass the bulb about 2 inches up the lower bowel, and leave in position for three minutes, when the patient is very collapsed. The readings given by this method are about 1° F. higher than in the others.

Shake the mercury down to below the 97° F. mark before and after use. After use, wash the thermometer in cold water.

Normal temperature is 98·4° F.

Normal pulse frequency: about 78 per minute.

Normal respiration rate: about 16 per minute.

To give a hypodermic injection

The best place to inject is the skin on the outer side of the upper arm or the thigh. Avoid inflamed areas.

The hands of the operator should be washed. Paint the skin over

the site of the injection with iodine, or cleanse with spirit on a wool swab. Clean the syringe and needle by boiling, the dismantled syringe being laid on a piece of gauze or cotton-wool in the sterilizer or saucepan; or place it in spirit for five minutes before assembly.

Make up the solution to be injected in a spoon that has been boiled, by adding the tabloid of drug to a little boiled water. Draw the solution into the syringe; then hold it needle end upwards, to allow any air to rise above the liquid, and push up the piston until all the air bubbles have been driven out and the solution begins to come through the needle.

Pinch up the skin where the injection is to be made and push the needle well through until its point is felt to lie in the loose tissues beneath the skin. Before making the injection gently attempt to withdraw the piston to make sure that it has not penetrated a vein; if no blood appears in the syringe the injection can safely be made. Slowly press home the piston until the required amount has been injected. Withdraw the needle and apply pressure for a minute with a small pad of clean cotton-wool over the puncture.

After the injection wash through the syringe once or twice with clean water, dismantle, and dry. Re-insert the fine wire which was in the needle before it was used, to keep the way through the needle clear.

Drugs for hypodermic injection are sent out either in tablet, or as a solution in little sealed ampoules. Each tablet or ampoule contains a stated dose. Dissolve tablet in about ten drops of warm boiled water; the exact amount does not matter since each tablet contains a known dose.

The hypodermic injections likely to be used are:

Morphia, to relieve pain: dose usually $\frac{1}{4}$ grain.

Strychnine, as a stimulant and following snake-bite: dose $\frac{1}{16}$ grain.

Potassium permanganate, for snake-bite.

To feed a sick person

Never attempt to give an unconscious person nourishment by the mouth because the food is likely to pass into the windpipe and the lungs. Fluid nourishment by a tube passed through the nose should be given only by a trained nurse or medical attendant; the correct alternative is to give a solution of glucose by the lower bowel. (See p. 386.)

If the patient is conscious but too weak to feed himself, turn the head to one side and feed with a spoon, allowing plenty of time for him to swallow one spoonful before the next is given. A feeding cup is more convenient, and can be made by attaching a short length of wide-bore rubber tubing to the spout of a small teapot. Insert the free flexible end of the tube into the mouth.

Toilet of the mouth

The mouth and tongue of a sick person, particularly if feverish, become foul very quickly. Proper cleansing of the mouth adds much to his comfort and prevents formation of ulcers. Remove false teeth and plates, and place in an antiseptic solution. Wipe the tongue and mouth gently round with a piece of gauze soaked in a solution of bicarbonate of soda (strength 1 drachm to a pint of water). Wrap gauze round the little finger, or better, tie as a pad round the ends of little wooden sticks to make a kind of brush. Cleanse the grooves between the cheeks and the gums from behind forwards, and the teeth with the stick-swabs. A little honey applied on the finger is comforting if the mouth is dry and sore.

In fever the lips become dry and cracked and even ulcerated; after cleansing the mouth apply sterile vaseline, hazeline ointment, or boric ointment. Cleanse the mouth at least every four hours and after food.

To give an enema

One may have to give an enema to bring about purgation, or to stop diarrhoea and relieve pain. The soap-and-water enema is mild and suitable in most cases, as for a patient who has become constipated by being confined to bed. An olive-oil enema is used when the constipation has been going on for some time and the motions have become so hard and dry that much pain is experienced in trying to pass them. This enema is meant to be retained, and to be followed four hours later by a soap-and-water enema to expel the softened faeces. A turpentine enema is used only as a more drastic measure when the other methods have failed. A starch and opium enema is quite often used in cases of typhoid to relieve pain and to quieten down the movements of the bowel.

For soap-and-water enema take a piece of soap about the size of a walnut and dissolve it in one pint of hot water. Any soft soap will

do, but not carbolic. The whole of the soap must be dissolved since any solid injected will cause pain. Give one pint at temperature 100° F.

For olive-oil enema: 4 to 5 oz. are given warm followed in four hours by a soap-and-water enema.

For turpentine enema: 1 oz. of turpentine is added to 1 pint of the soap-and-water enema and well mixed with it. Smear skin round the opening of the bowel well with vaseline, or excoriation will occur.

For starch-and-opium enema make 2 oz. of thin starch. Mix a little powdered starch with cold water to make a paste, and add boiling water to make a thin fluid to be used when it has cooled to 100° F. Some of the starch is poured into the funnel of the enema apparatus, then 30 minims of tincture of opium (Laudanum), and finally the rest of the starch on top. This enema is run in and is to be retained.

A soft rubber catheter (size No. 8) is joined by a glass connection to a piece of rubber tubing about one foot long, with a glass or other funnel at the other end. Alternatively, use a Higginson's syringe; its method of employment is obvious. A waterproof sheet and vaseline as a lubricant will be required.

Place the patient on his left side with the knees drawn up, or if he is too ill to be turned he must lie on his back. Place the waterproof sheet beneath the buttocks. First run the fluid through the apparatus to expel all air, and when it is full, nip the rubber tube to stop the flow. Lubricate the end of the catheter or nozzle and pass it for about two inches up the bowel. Then allow the fluid to run holding the funnel not more than one foot above the level of the bowel. If the patient complains of pain stop the flow for a minute or two by pinching the tube. Recommence, taking 5 to 10 minutes to run in the whole of the enema. Withdraw the catheter quickly and encourage the patient to retain the fluid for a time.

To give an Infusion by the Bowel

An infusion is intended to be retained and absorbed. The fluids given are: Normal saline (See drugs: sodium chloride); and Normal saline to which glucose is added in the proportion of 1 oz. to every pint. Glucose-saline is usually given when there is vomiting and when nourishment cannot be given by mouth.

The apparatus is the same as for giving an enema, but a Higginson's

syringe cannot be used. Place the patient on his back with a waterproof sheet under the buttocks. Proceed as when giving an enema, but take much longer over the operation. If at least 20 minutes is taken to run in every half-pint of saline, it should be possible to give 1 to 2 pints without the fluid being returned. Should the patient desire to return it, the flow must be stopped and the injection be resumed even more slowly than before. Leave him undisturbed for at least an hour, for any movement is likely to result in rejection of the infusion. Before giving an infusion, an enema must sometimes be given to empty the lower bowel.

Sponging and cold baths

To sponge and wash a sick person first remove his clothes and bedclothes, then cover him with a blanket. Roll up one side of a second blanket as far as its middle; this is the washing blanket. Turn patient on his side, place the folded edge of washing blanket down middle of bed, then roll him on to his other side so as to get hold of the folded edge of blanket in middle of bed to smooth it out beneath him. The washing blanket is folded forwards on either side so as to cover the patient before the other blanket is removed. Now uncover the limbs each in turn and sponge with slow upward strokes towards the body. Do not have the sponge too wet. Finish with the front and back of the body. Take about 15 minutes over the washing. Dry the skin carefully and powder the back. (See Prevention of bed sores.) Use water at 115° F.; but when there is fever over 105° F., as in malaria or heat stroke, use cold or iced water.

When fever reaches 106° and higher, as may happen in heat stroke, cold sponge; or better still lift patient on a blanket or ground-sheet and lower him into a cold bath. While in the bath rub the body and limbs locally to keep the circulation going, and watch the pulse and respiration rates all the time. Should pulse become weak and rapid remove him from bath and wrap in warm blankets. Always keep stimulants at hand when resorting to cold baths. (Hot coffee, Strychnine, etc.) Take the temperature with the thermometer in the lower bowel afterwards, and again an hour later. Remove from bath.

Prevention of bed sores

A bed sore is a local ulceration or sloughing of the skin where it has been subjected to pressure for a long time by contact with the

bedding; they are most likely in lengthy illness. The parts most likely to be affected are the lower back and the heels. A contributory cause is damp bedding, caused through soiling with urine and faeces. If the skin over any of these pressure points is red and dusky, a bed sore will probably develop, unless active steps are taken to prevent it. Once ulceration has occurred, it is particularly difficult to get a sore to heal.

When nursing see that the lower back is supported on something soft, such as an extra pillow, or better, an air ring. At the same time place pads of cotton-wool under the legs just above the heels.

As far as possible avoid all folds and creases in the bedding. Attend to this detail of nursing frequently. Treat the skin over the back and pressure points at least twice a day with spirit to harden it. Cleanse and dry most carefully whenever soiled by the excretions, and dust afterwards with boric acid and zinc oxide powder.

DISEASES AND DISORDERS

APPENDICITIS

An acute condition in which there is inflammation of the appendix, which if not treated promptly may lead to general peritonitis.

Symptoms in a classical case are: sudden abdominal pain, then nausea, vomiting, constipation, fever, and a rapid pulse. Pain at first is near the navel, but later settles down over the appendix, low down in the right side of the belly. Vomiting may occur only at the beginning of an attack, nausea usually remains. The tongue is dry and coated, and constipation is complete. The temperature reaches 100° to 102° F. but may be only 99° F. The pulse rate is 100 or more and continues to increase as the disease progresses. Great tenderness on feeling with finger-tips over the appendix, and the muscles here contract and become rigid; sometimes a lump can be felt, but the examination must be made gently for fear of bursting an abscess.

Call skilled aid at once. Failing this nurse the patient propped upright in bed with a pillow or bolster under the knees. Give nothing but water by mouth. To allay pain and restlessness give an injection of morphia and repeat in twelve hours if necessary. Do not give purges as they are dangerous. If possible carry the patient on a stretcher (in the position indicated above) to a place where an operation can be performed. If constipation causes distress an olive-oil enema may be given very gently, but should be withheld as long as possible. Careful nursing on these lines is always worth while since an abscess in con-

nection with the appendix may become localized and eventually disperse, or burst into the bowel and drain itself that way.

BERIBERI

A dietetic disease associated with a deficiency in vitamin B_1 and occurs frequently in tropical regions where rice is the main article of food.

Symptoms are weakness of the legs and digestive trouble, abnormal sensations in the legs, frequently associated with swelling. The gait alters and in the so-called wet beriberi the patient becomes bloated, as in dropsy. The disease is a peripheral neuritis, a form of paralysis, and in what are called the dry forms of the disease marked muscular wasting takes place.

Prophylactic treatment: provide a balanced dietary, rich in vitamins, especially B_1. Marmite, supplied in small cubes ¼ oz. in weight, taken once or twice a day, is useful; eggs, milk, fresh meat, lentils, oatmeal, and yeast should be included in the diet.

Curative treatment: rest in bed essential as otherwise the patient may die of heart failure. In wet cases, restrict the fluid. Diet as above. Massage, electricity, and tonics are required during convalescence.

BLACKWATER FEVER

Derives its name from the colour of the urine and is associated in some way with malignant forms of malarial fever. Certain parts of tropical Africa and of India are chiefly affected and it is usually met with in those who suffer from repeated attacks of malaria and have been irregular in taking prophylactic quinine. The exact cause not yet known; large doses of quinine, chills and depressing influences may precipitate the attack; recurrences are common and in people who have suffered, a prolonged rest in England is necessary.

Onset is frequently sudden, with high fever and pains in the back. Vomiting then begins, the skin becomes yellow and the urine port-wine or porter coloured. There is great restlessness and the patient is seriously ill.

Avoid getting malaria and blackwater fever will not appear. Those who take quinine regularly and in sufficient doses, as a prophylactic against malaria, will escape.

The three main causes of death in blackwater fever are (1) syncope, (2) suppression of urine, and (3) hyperpyrexia. Treatment should be based upon this knowledge. To prevent syncope, absolute rest in bed must be enforced; the patient must not even sit up; the bottom of the bed should be raised and, in severe cases, bandaging of the extremities may be called for. If medical aid is at hand, intravenous solutions of

glucose are administered or blood transfusions may be employed. Suppression of urine is indicated by the volume passed gradually becoming diminished until only a few ounces are passed in the twenty-four hours. Treatment must then be energetic. Fluids must be given to wash out the kidneys, by the mouth in the absence of vomiting, or otherwise transfusions of fluid into the subcutaneous tissues, the rectum, or intravenously. Apply poultices and hot fomentations to the loins. Hyperpyrexia can only be treated by ice; if this is not obtainable, sponging with water as cold as possible should be tried.

It is dangerous to move patients and they should be treated on the spot if possible. Skilful nursing will save many lives. Give small quantities of milk, plasmon, Benger's or Allenbury's food, at frequent intervals: later Bovril, Brand's Essence or Brand's Fever Food may be tried. If vomiting is excessive and the patient cannot keep such foods down, he must be fed by giving glucose intravenously. Quinine should at once be stopped when blackwater appears; if malaria appears again after convalescence, quinine may have to be given in very small doses, gradually increasing them. In other instances, the malarial infection is completely stamped out and further fever does not develop. After an attack the patient is weak and anaemic. Careful feeding and tonics, especially iron and arsenic, are required and it is specially dangerous to get chilled or wet.

BOILS

A boil is a localized septic infection of the skin in connection with a hair follicle or a sweat gland: called carbuncle when in a special situation, notably on the back of the neck. Both conditions may go on to abscess formation. A carbuncle is more difficult to treat because the matter is shut off beneath the skin in numerous loculi, all of which must be cut open before proper drainage can be effected.

Keep the skin clean to prevent blocking pores and hair follicles with "black-heads." In the tropics excessive sweating may cause a rash, of which the spots may become infected and start boils, so after the day's work or march thoroughly dry the skin. A quick sponge down, without using much soap, followed by drying, should form part of the daily hygiene. Lack of vitamins in the diet (notably vitamin A) predisposes to septic infections generally, so when fresh food cannot be obtained supply vitamins A and D in the form of halibut liver oil, 6 drops daily; or cod-liver oil, Adexolin, etc., in appropriate doses.

When a boil has developed the objects are: (1) to build up the patient's resistance; (2) to rest the affected part; (3) to increase the blood supply locally; (4) to let out matter when it forms. Therefore, give extra vitamins as above. Carry the arm in a sling when that is the site of

infection. Apply to inflamed area a dressing of magnesium sulphate paste spread on lint, and lightly bandage in position. Dress twice daily until boil is dispersed, or until it is pointing. Alternatively, apply hot fomentations or poultices every few hours. These are less satisfactory as they tend to make the surrounding skin unhealthy. When a boil is pointing let the matter out by cutting it open with a knife, using aseptic precautions (see Wounds). Make rapidly one incision through the skin at its reddest part until matter gushes freely from the wound. A common fault is to make too small a cut. Give an anaesthetic if possible, but failing this give injection of $\frac{1}{6}$ grain of morphia 20 minutes before the operation. Afterwards treat as a septic wound. Carbuncles are best treated conservatively with applications of magnesium sulphate paste.

Never squeeze a boil to express the matter because this only spreads infection under the skin. Boils on the forehead and round the middle of the face are serious on account of the danger of infection spreading to veins of the brain; it is particularly dangerous to squeeze them. In such cases patient should take to bed. Begin by giving a purgative, such as calomel 2 grains, followed by salts in the morning. Treat the boil conservatively by applying magnesium sulphate paste and don't incise it until it is well pointing, then make one small incision only.

BRONCHITIS

A condition in which there is inflammation of the windpipe and its branches. Bronchitis may follow upon a cold in the head or a sore throat, so treat these two conditions in the early stages.

There is a cough at first dry, but later loose and accompanied by frothy expectoration. In the early stages there is a sensation of rawness over the upper part of the breast bone. The breathing is difficult. The temperature is seldom raised more than a degree or two and the breathing is not rapid, two important observations for distinguishing this condition from pneumonia.

The patient should take to bed if possible in the early acute stages of the illness. Give 10 grains of Dover's powder at night for the first two days. If there is much tightness in the chest, give steam inhalations every four hours, by adding 30 minims of Friar's balsam to a pint of hot water and making the patient sit with his face over the steaming fluid with a towel over his head. Give a stimulating expectorant after two or three days to help get rid of sputum: 5 grains of potassium iodide and 3 grains of ammonium carbonate dissolved in 1 oz. (2 tablespoons) of water. Take an ounce of this mixture thrice daily after meals.

When the acute attack is over, take one teaspoonful of syrup of

codeine three times a day and at night to relieve the dry cough which so often remains.

BURNS AND SCALDS

The greater the area of skin involved, the more serious are the consequences. The dangers of a severe burn are due to shock, and septic absorption from the raw area on the skin. The worst burns and scalds are those in which a large area of skin is blistered or raw. In first aid avoid using greasy applications, difficult to clean off when the wound goes septic, which it often does. Cover instead with layers of gauze soaked in (*a*) sodium bicarbonate solution, 1 drachm to the pint of boiled water, or better (*b*) 2 per cent. solution of tannic acid. Swathe in cotton wool and bandage lightly. Treat shock in severe cases by keeping patient warm and quiet, and giving hot drinks such as coffee. Relieve pain with an injection of 1/6 grain of morphia. With severe cases, do not move patient or proceed to further treatment for at least half an hour and until morphia is working. Repeat morphia as may be necessary, in six hours' time.

Remove first-aid dressing and under strictly aseptic precautions, cut away dead skin and blisters (see Wounds). Thoroughly cleanse surrounding skin, if possible under anaesthesia. Cover with one layer of gauze, then spray or paint on 2 per cent. tannic acid; allow to dry before covering with more gauze and a second coat of acid. Thereafter repeat spraying and drying several times, without adding more gauze, until whole burnt area is covered with a white coagulum. This forms a protective scab, which goes black within twenty-four hours. When dry cover with wool, and bandage lightly. Examine daily and if matter seems to be collecting beneath the scab, cut away that part of it and treat underlying area as a septic wound, otherwise leave and allow to separate naturally as healing progresses beneath it. A tannic acid jelly with a watery basis is now available in collapsible tubes and should be applied in the same way.

Alternatively apply gauze dressings soaked in saturated watery solution of picric acid to burn, after cleansing and removing blisters. Change dressing daily. Picric acid sometimes causes a rash of no consequence.

CEREBRO-SPINAL FEVER: See Meningitis.

CHICKEN-POX

It is important to be able to distinguish it from the more serious smallpox, which is not infrequent in the tropics. A rash is usually the first sign of the disease: pink spots upon which blebs form within

12 to 24 hours, usually first on the face and trunk, and later on the upper parts of the limbs; they come out in crops and can be found in all stages of maturation. There are no constitutional symptoms beyond slight headache at the onset in some instances.

The disease differs from smallpox in the following points. In smallpox the constitutional symptoms are usually severe and the rash appears three days after their onset (see Smallpox); again in smallpox the rash begins on the face and limbs and spreads to the trunk. There are normally more spots on the limbs than on the trunk, the reverse in chicken pox. These spots are all at the same stage of maturation, and usually have a small depression at their centre.

Isolate the patient from those who have not had the disease until all scabs have separated. Confine to bed at the onset only if there are constitutional symptoms. Avoid scratching the crusts and allow them to separate naturally. If the pocks become inflamed apply boric lint fomentations and later dry boric lint dressings.

CHOLERA

An acute disease, characterized by frequent watery motions, vomiting, cramp, and collapse. It is due to an organism (Koch's *comma vibrio*) and is usually contracted by drinking contaminated water, but may also be spread by flies transmitting the organism to food. Cholera carriers exist; that is, a person may harbour the organism in his bowel, be in perfect health, but transmit the disease to other people by infecting water or food.

Symptoms are giddiness, faintness, persistent vomiting, and diarrhoea, great prostration, feeble pulse, cold perspiration, colic, intense thirst and constant desire to pass urine. The vomit and motions rapidly become like rice-water in appearance and the urine is more or less suppressed. There are severe cramps in the legs, belly, and other parts of the body. In fatal cases the pulse becomes weak and thready, the temperature falls and the patient sinks into unconsciousness. In cases that recover the symptoms gradually abate. The pulse, temperature and colour of the face become normal, urine is passed more freely, and the motions gradually become natural in colour again.

At times of epidemic boil all water and milk, avoid indigestible diet and raw fruit, raw vegetables, and meat jellies. Protect all food carefully from flies. Strict supervision must be maintained over the kitchen; plates boiled, and all kitchen cloths washed in permanganate solution. Patients and contact cases must be strictly isolated. Disinfect cholera stools by cresol, quicklime, etc.

Anti-cholera inoculations not only afford a considerable degree of

protection, but lessen the risk of a fatal issue. Where cholera is endemic take a little lactic acid in tea or add a little vinegar or 30 drops of dilute HCl to every ounce of drinking water if there is no means of boiling the water.

Isolate a patient with cholera, keep him warm and give pellets of ice to suck, apply hot bottles to the feet and mustard leaves to the pit of the stomach. Give very little food for the first few days, only water, with or without glucose, and barley water. Purgatives must not be given. Drugs are of little use. Some advise trying to destroy the cholera toxin by calcium permanganate (2 grains every ¼ hour for 8 doses, then half-hourly) or giving large doses of kaolin by the mouth. Chlorodyne is useful for allaying the severe pain.

The special treatment by hypertonic intravenous injections can be carried out only by a medical man: get his help at the earliest possible moment as everything depends on immediate treatment. If, after the acute symptoms subside, diarrhoea continues, bismuth is often useful. As the patient passes into the convalescent state, farinaceous foods are allowed, the quantity being gradually increased.

COLIC

A pain in the abdomen, caused by abnormally violent contractions of the bowel. It may be due to serious underlying disease, such as gastric ulcer, intestinal obstruction, or strangulated rupture; often however to simple constipation or a gastro-enteritis. As many conditions give rise to colic, consult the sections on Appendicitis, Indigestion, Rupture, etc.

If thought to be due to constipation, give a turpentine or soap-and-water enema (see Nursing). At the same time apply warmth to the abdomen by hot water bottles or poultices of hot kaolin spread on lint.

Should the pain be accompanied by diarrhoea, treat as in that section, and give 30–60 grains of aromatic chalk powder with opium every four hours for two or three doses until the pains abate.

CONCUSSION

The working of the brain is temporarily suspended as a result of severe shaking by a blow or fall.

Consciousness may not be lost, but the patient feels dazed, giddy and sick, and falls down. Later vomiting may occur and mental confusion remain. In severe cases he falls to the ground unconscious and cannot be roused; but sometimes he can be roused temporarily by shouting or by painful applications and may then shout. Unconsciousness may pass off quickly or remain for hours or days. The skin is pale, cold and clammy, the eyes are closed, the breathing is shallow

and the pulse irregular, either slow or rapid. The urine and motions may be voided involuntarily. The stage of reaction is marked by returning consciousness and vomiting, the skin becoming warm. Alternatively, inflammation of the brain (see Meningitis) may set in, or consciousness again be lost and death occur.

During the stage of shock, keep patient at rest with foot of couch raised, and apply warmth. During stage of reaction lower foot of bed and raise the head, give hot drinks and keep at rest in a quiet darkened place. Do not allow patient to attend to his own toilet. Give a purgative: 2 grains of calomel at night, followed by 2 drachms of Epsom salts (magnesium sulphate) in half a glass of water next morning. Give a light diet. Keep in bed at absolute rest and free from worry for at least two weeks, longer if possible. Unless collapse is alarming avoid all stimulants and alcohol. If a stimulant is necessary use aromatic ammonia (sal volatile).

CONSTIPATION

Remember that this is a symptom, and not a disease, and the first thing to do is to find out the cause. It may be simply faulty habits, or lack of exercise through confinement to bed. Or, it may be due to more serious underlying disease such as appendicitis, peritonitis, or strangulated rupture. In the latter instance, it can be one of the leading symptoms of the disease (see Diagnosis), and it may then be dangerous to attempt to purge the patient.

Having carefully excluded the possibility of such serious conditions, treat as simple constipation.

To avoid constipation take plenty of exercise, drink sufficient fluid, and be regular in habits. In mild cases give a dose of salts in the morning before breakfast; 2 drachms of Epsom salts (magnesium sulphate) in half a tumbler of water, or the same dose of Glauber salts (sodium sulphate). In more troublesome cases, give 1 drachm of Glauber salts every four hours throughout the day.

If the constipation is of long standing, it is probably best to give 1 to 3 grains of calomel at night and to follow with Epsom salts in the morning.

When the motions have become very hard as a result of chronic constipation or the presence of piles, much pain will be experienced in trying to pass them. Give an olive-oil enema to soften the faeces and follow it with a soap-and-water enema or one of the purges mentioned above. In certain cases castor oil is a valuable remedy; it produces a profuse evacuation about four hours after administration. But it is a drastic purge and often causes griping pains and even collapse; it is not a good one to use on all occasions. The dose is $\frac{3}{4}$ oz. in the tropics

and 1 oz. in temperate climates. Employ as given in the sections on diseases.

CYSTITIS

Inflammation of the bladder caused by injury; the use of catheters which have not been properly sterilized; retention of urine; or spread of gonorrhoea to the bladder.

Symptoms are pain in the lower part of the belly, and in the crutch; and constant desire to pass water, the act causing a burning pain. The urine is cloudy and foul smelling and is sometimes blood-stained. There is often some fever.

Relapses quite often occur, but treatment along the following lines will relieve the severe symptoms. Put the patient to bed. If there is much pain and difficulty in making water, sit him in a hot hip bath. Encourage him to drink large quantities of water or other bland drinks (not alcohol); three to four pints in the twenty-four hours. Give the following mixture by mouth every three hours at the onset and three times daily once the severe pain and fever have subsided: potassium citrate 60 grains, sodium bicarbonate 60 grains, made up to 1 oz. with water. Give light diet and plenty of bland fluid until the acute symptoms are past. Take the medicine thrice daily for at least a week or longer after this has happened. If relapses occur, treatment must be started again from the beginning, and it will be necessary to transfer the patient to a place where medical aid can be obtained.

DENGUE

This disease, also known as Dandy Fever and Breakbone Fever, occurs in many parts of the world; it is caused by a filterable virus, carried from person to person by a mosquito (*Aëdes aegypti*) the same that carries Yellow Fever. Dengue is specially prevalent on the sea coast.

Incubation period, from 5 to 10 days. Onset sudden, temperature rising rapidly. Within an hour or two an initial rash appears, the patient suffering from severe headache and pains in the joints and back, the condition resembling influenza, but there is no catarrh. Pain in the eyes and insomnia may be present. The high temperature lasts for 3 or 4 days, then drops, continues low for from twelve hours to three days and rises again sharply. During the interval the patient feels better but the symptoms recur when the temperature rises the second time. In the second stage the true rash appears, rather like that of measles, and is followed by desquamation. The disease, though often causing great weakness and persisting pains, is very rarely fatal.

Avoid by proper use of mosquito nets, or failing that, of mosquito repellants (see p. 409, 414).

Treat by light diet, rest in bed, phenacetin and aspirin for the pains and headache; cold sponging helps the febrile condition and the insomnia. During convalescence there may be depression. Give tonics and nourishing diet.

DIARRHOEA

A symptom and not a disease. Regard every case in the tropics with suspicion, until a diagnosis of dysentery or cholera can be excluded: often difficult, but always examine the motions which are voided. If they contain blood, or whitish, jelly-like material (mucus) then regard the case as dysentery and treat accordingly (see Dysentery). In a case of cholera, the patient passes clear, watery motions every few minutes, the so-called "rice water stools." The motions pour from him and he rapidly loses flesh, becomes restless, and complains of great thirst. He gets painful cramps in the muscles, which contract and stand out as hard knots under the skin. The condition may be so acute that he dies within forty-eight hours of the onset (see Cholera).

Hill diarrhoea is met with, particularly in India, in those who have been living in the hot plains and go up to the hills. They are sometimes prostrated with diarrhoea and stomach trouble for the first few days, and the condition is usually regarded as due to chill.

Wear proper clothing when going from hot to colder districts; particularly from the plains to the hills. A drop in the night temperature in the tropics constitutes another danger, so protect the abdomen with warm clothing at night time. Stomach trouble in camp can often be traced to dirty cooking pans; inspect the kitchen frequently.

Treat simple diarrhoea by starvation and purgation to get rid of the poisons, and then use "binding" drugs, to "damp down" the motions of the bowel. Put to bed if possible and give nothing at all by mouth for the first 24 hours, except water, or bland fluids such as lemonade, soda-water, barley water, etc. Then if the symptoms are abating, give a little light nourishment, such as bread and butter, boiled fish, or milk pudding. Should the colic and diarrhoea start again, revert to starvation. No harm can be done by keeping a man without food for several days, so long as he is given fluids by mouth.

Give a fairly drastic purge at the beginning and follow by a dose of salts each morning for the next few days, or give salts every few hours over a definite period. If the first method is chosen, give at once $\frac{3}{4}$ oz. castor oil, or 2–3 grains of calomel, with morning saline to follow of 1–2 drachms of Epsom salts (magnesium sulphate) taken in 4 oz. of water. Alternatively, make up a saline draught of 1 drachm of Glauber

salts (sodium sulphate) to every fluid ounce of water and give 1 oz. of this draught every three hours for the first 24 hours.

After the preliminary starvation and purgation for at least 24 hours, it is permissible to administer "binding" drugs. If the symptoms are severe, give 30–60 grains of aromatic chalk powder with opium; to quiet down the movements of the bowel and to relieve griping. In less severe cases give simply aromatic chalk powder in doses of 30–60 grains every 4 hours until the diarrhoea abates. Alternatively give 1 oz. of powdered kaolin in half a tumbler of water.

DIPHTHERIA

An acute infectious disease affecting the lining membrane of the nose, throat, larynx and wind-pipe, due to infection with the diphtheria bacillus, and contracted by contact with the disease or from a healthy carrier harbouring the organism in his throat or nose, or from infected milk, utensils, etc.

Symptoms are malaise, headache, sore throat, loss of appetite, and sometimes vomiting. The throat will be red and in places covered with a characteristic thick whitish-yellow membrane. Swollen glands will be found in the neck below the angle of the jaw. The temperature is raised, but not always greatly; the pulse is feeble and rapid, a noticeable feature. If the nose is affected there is a copious discharge, highly infective. The presence of croup and great difficulty in breathing means that the wind-pipe is involved; suffocation is then a serious and sudden danger.

Isolate in bed. Use separate cooking utensils and crockery, and boil before they are again used by other people. Burn soiled clothing, linen, and swabs. Nurse the patient lying flat.

The disease is very grave; seek medical aid at once. The most serious possibility is suffocation due to blockage of the wind-pipe, relieved only by opening the wind-pipe in the neck.

Give nourishing foods and stimulants frequently and in small quantities. Clean the mouth out frequently and use a hot saline throat spray. The bowels are best kept clear by giving enemata. Maintain the recumbent position for at least a week after recovery has commenced and even then the sitting position must be assumed gradually. No severe exercise for at least a month after recovery, on account of danger of damage to the heart.

Heart failure is a frequent complication, and if the pulse becomes very weak, give cardiac stimulants: brandy, one tablespoonful in a little water, every three hours, and an injection of 0·5 to 1 c.c. of the subcutaneous preparation of Coramine to strengthen the pulse. Alternatives are: strychnine $^{1}/_{16}$ of a grain, or camphor in oil 1 cubic centimetre.

Paralysis, particularly of the swallowing muscles, is another complication and may prevent the patient from taking food, which is regurgitated through the nose. Feeding through a nasal tube then becomes necessary and medical aid must be sought.

DROWNING

Recovery has been recorded when submersion has been so long as half an hour. Therefore always attempt to resuscitate.

Turn the drowned person face downwards with head lower than body. Open the mouth and pull out the tongue, pulling it forwards if necessary by a single stitch of thread transfixing it. At same time compress firmly the lower part of chest to squeeze water, saliva, and mucus from the air passages. Loosen clothing. Commence artificial respiration at once and persist with it for an hour, or for several hours if there has been the slightest sign of recovery. Schäfer's method is the one to use. Keep face downward with arms above head and face turned to one side. Kneel astride of him facing his head and place the palms of the hands on the lower part of his chest and loins, one on each side. From this position lean forwards with the whole weight of body, at the same time compressing the lower half of his chest. Keep up the pressure for two or three seconds then release suddenly. Repeat regularly about sixteen times a minute. Once natural respiration commences time the artificial movements to synchronize with it.

During artificial respiration get somebody to apply warmth to the body and give a hypodermic injection of $\frac{1}{8}$ grain of strychnine. After recovery give hot coffee, brandy, or other stimulants by mouth.

DYSENTERY

Due to inflammation, limited as a rule to the lower or large bowel. There are two chief types, amoebic and bacillary, due to quite different organisms; the former much more tropical. Both forms are transmitted in much the same way, symptoms similar, and the layman may consider them together.

Conveyed by impure drinking water, raw vegetables, food contaminated by flies, or by infected dust. In both forms, especially in the amoebic, carriers play an important part. In the amoebic form, the organism (amoeba) produces cysts which are passed by the bowel in the dejecta of persons even though no symptoms of dysentery are present. If these cysts find their way into food or water and are then swallowed, they develop in the human intestine into amoebae and infect the patient. In the bacillary form the patient harbours dysentery bacilli though showing no signs of the disease.

Symptoms are diarrhoea with pains in the belly, straining, and frequent desire to go to stool. The motions soon become small in amount, slimy, lose their natural colour, and contain more or less blood. When the ulceration of the bowel goes deeper, the motions become extremely offensive and blood and mucus take the place of faecal matter. Tenesmus (tenderness and bearing down sensations at the outlet of the bowel), prostration and a constant desire to pass water now appear. As a rule there is no fever in the amoebic form; in the bacillary the temperature is always raised and, in severe cases, considerably. A help in diagnosis, not very reliable, is the character of the stool. In amoebic dysentery the blood is mixed with the dejecta and is often dark in colour, the whole mass being brown or greyish-green; in bacillary dysentery the stool, which is whitish, has the blood bright coloured and often in the form of streaks or spots. The amoebic form, if not promptly and efficiently treated, may be followed by inflammation of the liver (hepatitis) and subsequent liver abscess.

Avoid chill and debilitating causes of all kinds. In countries where is a great difference between the day and night temperature, wear a cholera belt. Carefully protect food and water from contamination, especially from flies. Boil all water and milk. Do not employ native cooks who have recently suffered from dysentery; and observe scrupulous cleanliness in the preparation of food. Unripe fruit and other materials apt to cause diarrhoea should be avoided. Camp conservancy methods should be carried out on approved sanitary principles, which prevent the access of flies to human excrement and prevent the latter from being disseminated by wind or in any other way. All dysenteric stools should be carefully disinfected or burnt.

Treat both forms by rest in bed, warmth, and suitable food. In certain cases an initial dose of castor oil, half an ounce, with 10 drops of tincture of opium is useful. Milk may not be well borne; give albumin water, rice water, or chicken broth. Soups often useful and later custard, arrowroot, and jellies. In the bacillary type, give arrowroot, meat and fruit jellies, and beef tea from the onset. In both types give food in small quantities frequently, neither too hot nor too cold. Avoid all alcohol.

For amoebic dysentery there is a specific drug, emetine, given either by injection or by the mouth. Emetine hydrochloride, 1 grain, is injected deep subcutaneously every day for 10 days. Emetine bismuth iodide, 3 grains in a hard gelatine capsule, is taken every night on an empty stomach, for 12 consecutive days. If it causes vomiting, give 15 to 20 drops of tincture of opium half an hour before taking the capsule. Take no food after 6 p.m., the capsule at 10 p.m.

Under such treatment the symptoms rapidly clear up and the patient recovers; but relapses not uncommon.

In bacillary dysentery emetine is useless. Give saline treatment, 1 drachm (teaspoonful) doses of sodium or magnesium sulphate every 2 hours at first and then every 4 or 6 hours, until the stools become faeculent and bile stained. An anti-dysenteric serum is of value only early, given intravenously.

For relief of colic in both forms of the disease, turpentine stupes or poultices to the abdomen are useful. Chronic forms of both are common; detention in hospital necessary.

EARACHE

Can be due to a bad tooth, a boil in the outer ear, or inflammation of the inner ear. The latter may follow a sore throat or cold in the head.

Treat at first by hot fomentations, then put warm glycerine (or glycerine and carbolic) drops in the ear. Give 10 grains aspirin, or 10 grains Dover's powder to relieve pain and secure sleep. If there is discharge of matter, clean frequently with wool, followed by wool soaked in spirit, and then plug lightly. A copious discharge bringing relief from pain is a good sign.

ENTERIC OR TYPHOID FEVER, INCLUDING THE PARA-TYPHOID FEVERS

Medical attention and good nursing absolutely necessary for proper treatment. Paratyphoid fever may be considered as mild typhoid. Characterized by ulceration of the small bowel, with continued high fever, and usually, though not always, accompanied by diarrhoea. Acquired by drinking impure water, but also transmitted by flies, milk contaminated by water, oysters, and dirty vegetables. The incubation period is from 10 to 15 days.

The early symptoms are often so slight that one may feel only slightly out of sorts, or complain of headache, but still feel able to work. After five or six days one is generally compelled to give up and go to bed, with headache and diarrhoea or headache and constipation. Temperature characteristically rises a little more every evening, reaching 100° to 104° F. Congestion of the lungs, causing cough, may be present.

The abdomen is usually distended and slightly tender, and the typhoid rash of rose pink, circular, slightly raised spots about the size of a large pinhead, may appear, chiefly on the chest and abdomen, on successive days, often only three or four at a time. They may be absent and cannot be seen on a dark skin.

Remember the possibility of typhoid where there is constant fever,

without such definite symptoms as the rigors of malaria or the rusty sputum of pneumonia.

Prophylaxis is similar to that for dysentery (see p. 379). Preventive inoculation confers immunity for some time (see Inoculation, p. 399).

Treat by absolute rest in bed. If constipated keep the bowels open by soap-and-water enemata only. Give milk, 3 to 4 pints daily, or glucose water, during the whole course of the illness and till 10 days after the temperature has descended to and remained normal. If the pulse is feeble and rapid, stimulants may be required, and opium can be given if there is much pain. If bleeding occurs from the bowel, apply an ice bag or cold-water cloths to the abdomen; give ice to suck; and opium (10 to 20 drops of the tincture), or an astringent such as tannic acid (grains 5 to 10) may be administered by the mouth. An opium enema may also be employed. Give milk in small quantities only and to each half pint add five grains of bicarbonate of soda. Give no solid food.

Burn the motions or carefully disinfect; attendants should wear rubber gloves.

EPILEPSY

The most common form of fits, which pass through three stages: (1) The patient falls down unconscious, the face is pale, the limbs become rigid, and the breathing ceases. (2) Convulsive movements are made, the tongue may be bitten, the breathing is laboured so that the face becomes congested, and the motions may be passed unconsciously. (3) There is a state of mental confusion and drowsiness which is often followed by sleep. The fits are liable to recur.

Prevent the sufferer from injuring himself. Loosen tight clothing, and place the handle of a spoon, a piece of stick, or a cork between the teeth to prevent biting the tongue. After the fit give potassium bromide 10 to 20 grains, three times daily after meals.

EYE INFLAMMATION

May involve the eye-ball itself, as a result of penetrating injury, very serious; or may affect the membrane covering the eye (conjunctivitis). A sty results from inflammation in the eye-lid and is really a boil in this particular situation. A foreign body in the eye may be either on the membrane covering the white eye-ball, sometimes tucked away beneath the lids; or on the clear central portion of the eye, when it is usually difficult to see.

With inflammation of the eye-ball there is pain, dimness of vision, and a clouding of the transparent portion of the eye. The condition is urgent; seek skilled aid. Meanwhile, turn down the lower lid, place

an ophthalmic tablet 1/200 grain of atropine sulphate on its inner surface and allow to dissolve. The atropine should cause the pupil to dilate; keep dilated by a fresh tablet every day. Apply hot fomentations and shade the eyes with dark glasses. General measures are important; open the bowels at the onset with an aperient.

Conjunctivitis causes smarting and a gritty sensation behind the lids, which become red and congested. The condition is generally due to dirt or dust or a foreign body; also present in snow-blindness.

When no foreign body can be found irrigate the eye with boric acid and zinc eye lotion, made by dissolving one tablet in 2 oz. of clean water; use an eye bath.

To search for a foreign body evert the lids and inspect the back of them: best done by placing a match parallel to the lids, but away from their free margin; then by pulling on the lashes and at the same time fixing the lids with the match, they can be everted upward or downwards. A foreign body when seen should be gently wiped away with a small camel-hair brush or the corner of a clean handkerchief. Then irrigate the eye as above.

A foreign body on the clear portion of the eye causes intense pain, with much watering; and sometimes a leash of blood vessels can be seen running across the white part towards the central clear portion. Very careful inspection may detect the body. Have the patient sitting down, stand behind him and make him tilt back the head so that it rests on the back of the chair. Hold open the lids and systematically inspect the cornea or clear portion by telling him to look first upwards, then downwards, to the left, and to the right. When the body has been seen, place one ophthalmic tablet of 1/20 grain of cocaine hydrochloride in the lower lid, to dissolve. It is impossible to remove anything from this highly sensitive part of the eye, without first abolishing sensation. At the end of ten minutes attempt to wipe the body off the cornea with a soft camel-hair brush; generally impossible. Then use the eye spud, a flat blade-like instrument. Use great care for fear of penetrating the cornea, but a very gentle scoop will usually remove the particle. Then allow one tablet of 1/200 grain of atropine sulphate to dissolve in the eye, and instil 1 drop of castor oil. Keep the eye covered with a shade for the next 24 hours, until the effect of the cocaine has passed off: otherwise there is risk of getting another body into the eye.

For snow-blindness, see special section.

FAINTNESS

Due to anaemia of the brain, sometimes a symptom of sudden internal bleeding.

In every case put the patient flat, loosen his clothing, and see that space is cleared round him, so that he can have fresh air. At the same time, stimulate by crushing a capsule of aromatic ammonia beneath his nostrils. In simple faintness, these measures should result in rapid recovery.

But if after regaining consciousness the patient becomes very restless and is obviously ill, the respirations are sighing, and the pulse is thin, there is almost certainly internal bleeding. Seek medical aid; meanwhile give $\frac{1}{4}$ grain of morphia by hypodermic injection; keep the patient warm with hot-water bottles, and as quiet as possible.

FROST BITE

Cold brings on a spasm of the minute arteries carrying blood to the skin, which, as the blood supply is cut off, begins to die. More dangerous when the oxygen pressure is low, at high altitudes.

The fingers, toes, ears, and nose are particularly affected. The parts become numbed and then lose all sensation. The skin is white and cold and a condition of death, or incipient death of the tissues results.

As the circulation is restored the parts become blue and congested, with agonizing pain. If the frost bite only slight, some hours later the fingers or toes will become swollen and inflamed and watery blisters may form on the skin.

To avoid frost bite wear suitable clothing, particularly round the ears and face; and boots big enough to allow free movement of the toes; tight boots are dangerous. If sensation in the toes is failing call a halt, remove the boots, and massage the toes. Never postpone this halt for lack of time.

Aim at restoring circulation to the part very slowly, and, if blisters form on the skin, or tissues die, at keeping the wound clean and dry. Never warm the affected part quickly. If fingers have become frost bitten, remove the gloves and massage the fingers with snow until circulation begins. Then very cautiously, by further massage without snow, improve the condition still more. When circulation is completely restored, clean the skin gently by washing it with cold water, dry carefully, and apply zinc oxide and starch dusting powder, covering the whole area affected with sterile boric lint dressing, and bandage lightly. Examine the skin every day for blisters, prevent them from breaking if possible, but should they do so cut dead skin carefully away with scissors, in strictly aseptic conditions, and powder and dress the wound as before. Should a wet sloughing condition of the whole part supervene, it is an indication for amputation.

GONORRHOEA

This disease, also known as "clap," is an acute inflammation of the urethra or "pipe." The inflammation may spread to the bladder and cause cystitis; and unless care is taken to destroy soiled linen and keep the hands clean, the disease may be spread to the eyes. The infection is nearly always due to direct contagion and is not infrequent amongst natives.

The infection starts with a yellowish-white discharge from the pipe. After three or four days great pain is noticed on passing water, there is a thick yellow discharge, and the lips of the opening of the pipe are reddened. At first there may be a constant desire to pass water, but later on there is often difficulty.

Constitutional symptoms are usually slight: headache, slight fever, constipation, with a coated tongue. There is pain in the crutch and the glands in the groin are frequently swollen, hot and tender. After another week or ten days these acute symptoms subside and the discharge becomes thin and white, a condition known as gleet.

In those chronically infected with gonorrhoea, acute exacerbations may be brought on by exposure to cold and other debilitating conditions, and by alcoholic excess. Remember that relapses are liable to occur under these conditions, and when vetting native servants before starting, reject those who obviously harbour the infection.

Treat during the acute stage by rest in bed with the testicles supported on a pillow. Receive the discharges on to gauze dressings which are burnt when soiled. Remove the dressings with forceps, and wash the hands after each change. Both patient and attendant must take great care not to rub the eyes. Alcohol in any form is forbidden. Take large quantities of bland fluids, water, lemonade, etc., at least three to four pints a day. Open the bowels daily by giving 2 drachms of Epsom salts before breakfast. Give sandal-wood oil, 15 to 20 minims thrice daily in capsules.

When the acute stage is over and the discharge has become thin the patient can get up, but must avoid alcohol and undue exposure. Better not attempt irrigation of the pipe with antiseptics except under skilled supervision, certainly not during the acute illness.

If the glands in the groin become tender and inflamed apply kaolin poultices every three or four hours until the condition has subsided. If the glands suppurate treat as for boils (see p. 390).

HAEMORRHAGE

The bleeding may come from an artery, a vein, or the minute capillary vessels in the edges of a cut surface. In arterial bleeding the blood gushes out in spurts and is bright red; in venous haemorrhage

it flows in a steady dark-red stream. In capillary bleeding there is a general oozing from a cut surface.

The bleeding may be internal, as when the liver or kidney is ruptured by a blow over it, or external when a vessel is severed at the surface of the body. After severe haemorrhage the symptoms will be: restlessness, thirst, sighing respirations with air hunger, faintness, dim vision, singing in the ears, and sweating. The lips, mouth, throat and tongue are dry. The pulse is very rapid, easily compressible and eventually difficult to feel.

Arterial haemorrhage is said to be primary when the result of a wound or accident; reactionary when it recurs within 24 hours of an accident or operation, by failure of the temporary means for arresting the bleeding; and secondary when it occurs later than 24 hours after the injury and is due to a septic condition of the wound.

As first aid in arterial haemorrhage, apply pressure to the artery nearer the body than the wound. In an emergency press with the thumb until a ligature or tourniquet can be tied round the limb. Place the tourniquet so that the main artery of the limb is compressed against a single bone, *i.e.* round the thigh if the foot or leg is the site of haemorrhage; round the arm if it is the hand or forearm. If handy use a stout piece of rubber tubing; failing this a twisted handkerchief or strip of torn-up clothing. To tighten insert a stick between ligature and skin, then twist. The tourniquet will be more efficient if a pad is inserted between it and the skin to make pressure over the main artery; use a wad of folded gauze, a cork, or a round stone. When bleeding has been arrested, cleanse and dress the wound temporarily. Since the tourniquet must be removed as soon as possible, hurry with permanent measures. In any case loosen every two hours to flush the limb with blood. When haemorrhage has been arrested by permanent measures see that the wound is covered with a large dressing firmly bandaged in position before undoing the tourniquet. A tourniquet must never be used to control venous haemorrhage.

Venous haemorrhage can always be arrested by light pressure with a pad over the bleeding point. Apply the pad, remove any obstruction between the wound and the body in the form of garters, tight clothing, etc., and elevate the limb. Fix pad in position by a firm bandage which is applied from below upwards and includes *all* that part of the limb below the wound.

For permanent treatment of primary arterial haemorrhage, find both ends of the divided artery in the wound and tie off permanently with ligatures under strict aseptic conditions (see Treatment of Wounds). First cleanse with flavine, Dettol, or other antiseptic, then search for ends of divided artery. Temporarily releasing the tourniquet

will facilitate finding the upper end if there is difficulty, since blood will then spurt from it. Pick up with Spencer-Wells forceps and ligature with sterile thread, or cat-gut close to forceps; cut ends of ligature short and remove forceps; relax tourniquet and note whether bleeding has stopped. If there is still arterial haemorrhage search for second bleeding point and deal with this also. Some capillary oozing is to be expected on relaxing the tourniquet: control by re-applying tourniquet, closing wound with interrupted stitches of fishing-gut, and applying a large dressing with a firm bandage before again releasing it.

In secondary arterial haemorrhage a tourniquet must be applied, the wound re-opened, and the end of the bleeding vessel found and ligatured. If sloughing tissue prevents application of forceps, vessel should be underrun with a deep stitch of thread or cat-gut. A curved needle gripped with artery forceps is convenient for the purpose; pass the stitch deeply into the tissues surrounding the artery. Wound must then be thoroughly cleansed with antiseptic lotion, sloughs removed, and a light packing of gauze soaked in the lotion left *in situ*. Over all a light dressing is kept in place by firm bandaging. The limb must be kept elevated, and dressing inspected daily.

Reactionary haemorrhage is treated as primary haemorrhage; capillary is stopped by pressure, and applications of heat, cold, or haemostatic lotions. Use sterile water at 118° F., or cold water or ice. Adrenaline (1 in 1000) is a haemostatic lotion; dry the wound before it is applied. Treatment usually not difficult. Pack cavities from the bottom upwards with ribbon gauze and apply a firm dressing (see also Nose bleeding, Piles). When signs of severe blood loss are present, keep patient quiet and warm with foot of bed slightly raised; wrap limbs in cotton wool and bandage from below upwards; give $\frac{1}{6}$ to $\frac{1}{4}$ grain of morphia hypodermically to prevent restlessness and rise of blood pressure. Do not give stimulants. Replace the fluid lost by frequent small drinks of water, lemonade, etc., and in severe cases, infusions by the bowel (see Nursing).

HAY FEVER

A seasonal condition which affects those sensitive to certain emanations, animal and vegetable, notably the pollen grains of grasses and plants.

Symptoms are severe nasal catarrh, which may cause sneezing, obstruction to breathing and some deafness. The eyes tend to run.

Those known to be pollen sensitive should undergo desensitization before the pollen season.

To relieve symptoms during the season: wear dark glasses; take

ephedrine hydrochloride 1/4 to 1/2 grain by mouth, night and morning. In very acute cases take 5 minims of adrenalin hydrochloride hypodermically.

Wash out the nose every four hours with sodium bicarbonate 5 grains, sodium chloride 5 grains, made up in 4 oz. of water. Anoint the interior of the nostrils with vaseline to prevent them from becoming sore.

INDIGESTION

Acute indigestion can give rise to alarming symptoms superficially like more serious complaints, as appendicitis.

Symptoms come on soon after a large meal has been eaten hurriedly, usually at the end of a tiring day's work without food. There is pain in the upper part of the belly or near the navel, either continuous or colicky. At same time there is nausea but seldom vomiting; when vomiting does occur it brings relief. Patient usually easiest sitting upright rather than lying flat, but pain may be severe enough to double him up. It causes shock so that skin is cold and sweating, pulse is feeble and rapid, and the expression anxious. The temperature may be subnormal; it is not raised. Distinguish between simple indigestion and (1) appendicitis, or (2) perforated gastric ulcer. In appendicitis pain always precedes vomiting, which may be absent; eventually pain localizes to right side low down. There is always tenderness. Temperature often raised, and pulse rate increases hour by hour (see section Appendicitis). In perforated ulcer shock is severe, temperature subnormal, and pulse continues to increase. In cases of doubt proceed to—

Put to bed and keep warm, with hot applications to the sore belly. Record the pulse rate half-hourly and take the temperature. Give soda-mint tablets to suck.

If indigestion is correct diagnosis these measures will bring relief within an hour. Pulse rate is the best guide: if it remains rapid or increases still further the case is serious and skilled aid essential.

INFLUENZA

Tends to occur in epidemics and is spread by contact. When introduced into a tropical country, it is likely to spread rapidly among the natives and to cause many deaths.

The patient feels shivery and complains of headache and pains in all the limbs. Soon there is a dry cough and a feeling of rawness over the breast bone. There is fever up to 102° to 104° F., coated tongue and constipation.

In uncomplicated cases the fever and acute symptoms last only two

or three days, but the patient is left with a troublesome cough and weakness. Broncho-pneumonia is a fairly common and serious complication of influenza (see Pneumonia).

Isolate all cases; attendants should breathe through a face mask of gauze. Put the patient to bed. Give 3 grains of calomel, with a saline purgative next morning. Aspirin gives relief of headache and limb pains: 10 grains every four hours. There is no other specific treatment, but careful nursing of great importance.

INSECT PESTS: WINGED (see also Myiasis and skin diseases)

MOSQUITOES are the most important in the tropics, as they transmit malaria, yellow fever, dengue fever, and filariasis. Anopheline mosquitoes, the transmitters of malaria, can be recognized by their spotted wings and their appearance of standing on their heads when resting on a flat surface. Culicine mosquitoes, which include *Culex fatigans*, the carrier of filariasis, and *Aëdes aegypti*, the carrier of yellow fever, usually have unspotted wings and rest parallel to the surface. The larval stage of mosquitoes is spent in water.

The best protection against mosquitoes is a net, mesh at least 16 holes to the linear inch. Mosquito boots or buskins are useful, and hoods for the face and neck where mosquitoes are specially troublesome.

Applications to the skin, of cassia oil with brown oil of camphor in vaseline, or vermijelli containing citronella oil, are effective but unpleasant. To relieve irritation of bites, apply tincture of iodine.

SANDFLIES, which cause sandfly or phlebotomus fever (see p. 423), are tiny, hairy insects which breed in damp places, such as dark and damp cellars, cracks and fissures in the soil, tunnels, etc.; they may be very troublesome. Repellants, such as those used against mosquitoes, or eucalyptus oil, camphor and tobacco smoke help to keep them away. The ordinary mosquito net is useless and a net, to be effective, must contain 22 holes to the linear inch.

BUFFALO GNATS (*Simulium*) are often called sandflies. Their larval stage is passed in running water, such as cataracts and rapids, and they are formidable biters. They spread a disease called Onchocerciasis (a form of filariasis). Same protective measures as against mosquitoes and sandflies.

HOUSEFLIES distribute harmful bacteria and protozoa; they contaminate food by carrying the organisms on their bodies, wings, and legs, or deposit them by regurgitation or in their droppings. Protect all food and drink from flies and destroy them when possible. Use wire mesh fly covers to screen food, and cover vessels containing milk, etc., with muslin or calico weighted with beads.

TSETSE FLIES will be considered under Trypanosomiasis (see p. 434).

CONGO FLOOR MAGGOT is the larva of a fly found in parts of Africa; it infests the floors of native huts and sucks blood at night. So far as is known, it does not convey any disease. Avoid by general cleanliness and sanitary measures, use of high beds, scrutiny of sleeping-mats and blankets in which eggs or larvae may be concealed. Burn infected huts or, if this is not possible, fire the earthen floor. Wherever possible, have concrete floors.

INSECT PESTS: WINGLESS

LICE transmit typhus and relapsing fever and often, by their bites, cause great irritation and itching. Not easy to get rid of them when the infection is on a large scale. Head lice and pubic lice (crabs) may be recognized by their eggs, known as nits, minute, yellowish-white, goblet-shaped bodies attached to the hairs. Examine by use of a fine-tooth comb. Examine persons suspected of harbouring body lice first for the actual bites of the insect on the skin, then their clothing for the parasites or their eggs.

The best preventive is strict personal cleanliness; clothes frequently changed and washed; hair cropped short, especially at the sides and back of the head; in the tropics shave all hairy parts of the body.

Destroy lice by hot air, steam, boiling water, or hydrocyanic gas; comb the heads of those infested with head lice, treat with paraffin, petrol, or white precipitate ointment, and then well wash with carbolic soap. Loosen nits on the hair of the head or pubis with warm vinegar or acetic acid. For body lice, apply to the underclothing a grease of crude naphthalene, 4 parts, soft soap 1 part. Iron clothes, especially along the seams, with heavy, hot irons.

FLEAS spread bubonic plague and some diseases of animals. They dislike powdered naphthalene and pyrethrum powder; either of these applied to the clothes may ward them off.

CHIGGER FLEA or JIGGER: See Skin diseases.

BEDBUGS are common in hotels or inns abroad. They harbour in wooden beds and bedding, crevices in walls, floors and ceilings, and other places dark and sheltered. Though, as far as we know, not carrying any disease, their bites are annoying and their presence is a sign of insanitary conditions. A skin ointment like vermijelli and powdered naphthalene or Keating's powder may ward off the insects to some extent. Keating's contains pyrethrum, is slow in action, and should be shaken over the sleeping-bag or blankets some hours before bedtime. In heavily infected quarters, rub the powder into the skin as well.

ITCH insect is the cause of the skin disease known as scabies. The female mite burrows under the skin to lay her eggs. The fingers and other parts of the body may be affected and the rash may assume various forms. Itching is worst at night. Wash the skin well with soap and hot water and rub sulphur ointment in twice daily for three days, or better still take sulphur baths. Infected clothing or bedding should be boiled or destroyed.

TICKS. The most important, at least in Africa, spreads tick fever (see p. 433). The fowl tick also may attack man and spread another form of relapsing fever. The larvae of certain ticks burrow into the skin, and adults attach themselves to it. Never remove adult ticks by force, or the skin is damaged and the tick's rostrum breaks off and remains buried, causing severe irritation leading to sepsis. Dip a small brush in turpentine and insert between the skin and tick, which will then let go; or smear with vaseline. When the rostrum has broken off in the skin, apply cocaine and extract with fine needle forceps; then apply iodine. For the larval stages, harvest bug or bête rouge, touch spot with pure carbolic or apply sulphur ointment.

ANTS often attack foodstuffs. Check with pyrethrum powder, such as Keating's. Stand legs of tables in tins of water and paraffin or tie paraffin-soaked rags round them. Powdered borax or paraffin deal with ant-routes into tents or houses.

JAUNDICE

Caused by several infectious diseases, notably malaria, yellow fever, kala-azar, and Weil's disease; the common form known as infective catarrhal jaundice. This may begin with shivering, followed by fever up to 101°–102° F.; headache, prostration, loss of appetite, nausea, and even vomiting. The patient is usually constipated and has a heavily coated tongue. He may complain of pains in the back and limbs and of intolerable itching of the skin. The yellow is first noticed in the whites of the eyes, and as it deepens the mucous membranes of the skin become yellow also. The urine is dark and the motions are white and look like clay. Common jaundice varies in intensity, usually yellowest about the tenth day, after which it begins to fade, and fever and other symptoms subside, although relapses may occur.

Treat all cases in which there is jaundice on the following lines; but those due to a specific cause, such as malaria, should receive also the treatment for that disease. Put the patient to bed and at the onset withhold all solid food. Give instead plenty of bland fluid, such as lemonade and orangeade, with 4 oz. of glucose (sugar) for every ½ pint. On the first night give 2 grains of calomel and thereafter 2 drachms of Epsom salts (magnesium sulphate) in half a glass of water every

morning. The salts help to drain the biliary passages and relieve constipation. Once the fever has subsided and the jaundice is beginning to wane, add to the diet, but fatty foods last of all and with great caution. Skimmed milk, boiled fish, custards, and jellies may be given first; later on whole milk, bread or toast with a little butter, meat and eggs, but avoid fried foods for some weeks after complete recovery.

Remain in bed until the temperature is normal and the jaundice gone. Take special care to avoid chill.

KALA-AZAR: See Leishmaniasis.

LEECHES

Often troublesome and in some instances dangerous. The Asiatic leech, found in India, Ceylon, and the Far East generally, is very small, only about an inch long and about an eighth of an inch thick; can penetrate through the interstices of clothing and almost any kind of boot or puttee. The bites are painless and much blood may be lost before their presence is discovered. Carry a solution of salt, the application of which causes the leech to lose its hold. Do not drag them off the skin, as parts of the biting apparatus are apt to be left behind, and will set up inflammation and suppuration. Apply tincture of iodine to the bites. In forest regions, where these leeches abound, protect at night by a mosquito net of very fine mesh.

The tropical water leech, found in the Azores, Canary Islands, Africa, Palestine, Syria, Armenia, and Turkistan, may reach a length of four inches and if swallowed with drinking water usually fastens on the mucous membrane of the mouth or throat; also may pass up into the nose. Gargling with salt water will remove it. Boil drinking water or pass through muslin.

LEISHMANIASIS

The generalized or systemic form is called Kala-azar in India. The disease occurs notably in Assam, but also throughout the Far East, in Arabia, in the Anglo-Egyptian Sudan, and in the Mediterranean littoral. The parasite lives in the endothelial cells of the tissues, and is probably transmitted by sandflies.

Begins indefinitely, then continued fever, with enlarged spleen and liver, and progressive emaciation; bleeding from the nose and gums is not uncommon. Often mistaken for malaria, but distinguished by blood examinations and by finding the characteristic parasites by puncturing the liver.

Avoid the bites of sandflies (see p. 409). Cured by antimonium tartaratum or some of the pentavalent organic preparations of antimony, such as Neostibosan, given intravenously by skilled aid.

LIVER ABSCESS

May be suspected if a patient, convalescent from dysentery, remains feeble and ill or (even if there is no dysenteric history) has an irregular temperature, a muddy complexion, night-sweats, wasting, and pain or uneasiness in the right shoulder; dry cough not uncommon.

Before a liver abscess forms, there is a stage of inflammation. Emetine, as given for amoebic dysentery (p. 400), will cure this and sometimes symptoms, very suggestive of the abscess having formed, will also clear up under this drug. Bring a patient under medical control as quickly as possible. Ammonium chloride 10 grains sometimes useful.

MALARIA

Of all diseases in the tropics, malaria is the one most likely to trouble the traveller. Malaria is caused by a small animal parasite (a protozoon) which, in one of its stages, lives and multiplies in the blood corpuscles of man. When certain of these parasites (the gametocytes) are sucked up by Anopheles mosquitoes from the human subject, they develop in the stomach and finally produce bodies which get into the salivary glands and so are injected back into man with the saliva when the mosquito bites again. Culicine mosquitoes do not carry malaria. Anopheles breed in shallow puddles and in almost all stagnant or gently flowing water; therefore do not pitch camps close to pools, sluggish streams, or marshes. In the tropics, the chief reservoirs of infection are the natives, and more especially the children who harbour the parasite in the form adapted for reproduction in the female mosquito and hence are a distinct source of danger. The male mosquito does not bite, and is therefore harmless. Do not camp near native villages or habitations unless sufficiently protected from the bites of mosquitoes.

There are three forms of malaria: tertian, quartan, and malignant. In the first, fever comes every third day; in the second, every fourth day; and in the third, every third day or more commonly irregularly. In tertian and quartan fever, known as benign, the fever is usually intermittent; that is, between attacks the temperature returns to normal or lower. In malignant, the fever is remittent; that is, the temperature keeps above normal, and the higher the fever and the slighter the difference between the extremes of temperature, the more serious is the condition. If a remitting fever does not respond to quinine, it is probably not malarial and may be enteric (see p. 401).

Rigors or shivering are common to all forms of malaria, but best seen in the benign. The attack (ague) may be sudden, but is usually preceded by languor, yawning, and general discomfort. This is followed by the cold stage; the patient feels chilly, the skin is cold,

though, if the temperature be taken in the rectum, it will be found to be rising. Violent vomiting is not infrequent at this stage. The hot stage, often of long duration, comes next; the patient's skin feels burning hot, he has a splitting headache, and often becomes delirious. After a time tiny drops of sweat appear on the forehead, just under the hair, and gradually spread all over the body, bathing the patient in a perspiration. This is co-incident with the fall of temperature, and the rigor or ague attack is then finished. The whole attack usually occupies 6–10 hours, say one for the cold stage, three or four for the hot stage, and two to four for the sweating stage. An interval of one day (benign tertian), two days (quartan), or anything from a few hours to a day (malignant) now occurs. There is often pain and discomfort in the left side, owing to congestion and enlargement of the spleen.

By far the most important prevention is an efficient mosquito net: the oblong type best, with sixteen meshes to the linear inch. Round the foot sew a stout band of calico, two feet wide; tuck a foot of the material under the mattress, while the upper foot remains as a belt round the bed. Without it the sleeper may be bitten through the net which his arms or legs are apt to touch. See that the net is kept in good repair, and in malarial countries provide every member of an expedition, native or otherwise, with a good net.

One is very apt to be bitten just after sunset; use a canopy, such as mosquito umbrella tent, arranged so that the evening meal can be taken in it. One servant will be inside the canopy and receive the dishes through a guarded opening from the attendant outside.

The best mosquito boot goes right up the thigh, made of untanned leather or of stout khaki cloth, with soles to protect the feet from damp. Or wear two pairs of stockings; mosquitoes will not bite through them. Women can protect their legs and ankles in this way, or wear the buskin, leggings, gaiters or puttees; and mosquito veils, best being the "Mosquinette" hood.

Mosquitoes will bite through chairs with perforated seats; guard by a layer of brown paper, newspaper, or a cushion.

Repellent substances may be smeared on the skin; they contain essential oils, such as oil of cassia, citronella, or eucalyptus. The Burroughs Wellcome preparation "Sketofax," put up in tubes, is useful and easy to carry. These repellants are effective only for a short time, but they do lessen the liability of being bitten by mosquitoes and other insects.

Quinine is a valuable prophylactic, if properly employed. The drug is rapidly excreted and the time of taking it is therefore important. Take a dose of 5 grains with the evening meal, shortly before sunset; this will protect until it is time to get under the mosquito net. If for

any reason latter not available, then a second dose at 11 p.m. or midnight. Quinine useless in the morning, merely an auxiliary, and does not do instead of mosquito net. Avoid sugar-coated quinine; should be readily soluble; crack the tablets before swallowing; pills are useless. The best quinine is bi-hydrochloride; Burroughs Wellcome, 5 grain, uncoated tabloids are good. Take regularly every day and not haphazard. Persons who take their quinine regularly do not suffer from blackwater fever; irregular taking appears to favour that disease.

The three great principles of treatment are (1) to open the bowels, (2) to produce perspiration, and (3) to give quinine or atebrin. Put the patient to bed in flannel pyjamas and cover with blankets. Unless there is diarrhoea, give an aperient, and if not effective, a warm-water enema. Hot-water bottle in bed; sponging with warm water often gives relief at the onset and shortens the cold stage. Give hot drinks, as weak tea, to promote perspiration and cut short the hot stage. Phenacetin, 10 grains, in early stages relieves headache and general discomfort.

During the hot stage apply cloths wrung out of cold or iced water and sprinkled with eau de Cologne, vinegar, or spirit, to the forehead and behind the ears. Lighten the bedclothes and if asked give lemonade or water. If the temperature shows signs of getting above 106° or 107° F. sponge with cold water and have ice ready. "Cradling" the bedclothes from contact with the body is useful. In the sweating stage, strip off soaked pyjamas, and get into warm nightclothes and bedclothes. If there is any tendency to collapse, give brandy or whisky; but in most cases alcohol is better avoided. If vomiting is bad, withhold all food and give pellets of ice to suck.

This relieves the patient for the moment; next give an antimalarial drug as soon as possible, usually quinine, best administered by the mouth, in solution or as uncoated tabloid: 30 grains every 24 hours in 3 doses of 10 grains each at 9 a.m., 2 p.m., and 9 p.m., or in 5-grain doses every 4 hours, at 6 a.m., 10 a.m., 2 p.m., 6 p.m., 10 p.m., and 12 midnight.

In the benign forms temperature quickly drops and the patient is soon himself again. In malignant cases it is more difficult to break the fever, and if there is vomiting it may be necessary to inject the quinine intramuscularly, or, by a doctor, intravenously: this latter essential in coma. Keep the patient in bed if possible for ten days or, if this impossible, for at least five. Reduce the quinine after 4 or 5 days to 20 grains a day, then to 15, and then to 10, the last being given 5 grains in the morning and 5 grains in the evening, and continued for 3 months, to prevent relapses. A new drug, atebrin, is useful in cases which resist

quinine: $1\frac{1}{2}$ grains, three times a day for five days, can be obtained in little bottles containing the five days' doses. Carry this, as well as quinine, in malarial countries. Restrict food, during the fever, to chicken broth, eggs beaten up with milk, raisin tea, glucose water, etc. During convalescence give tonics, such as iron and arsenic. After repeated attacks of malaria, have a period at home in England, to eradicate the infection.

MALTA FEVER: See Undulant Fever.

MENINGITIS

Inflammation of the membranes covering the brain and the spinal cord, it is caused by infection; it is also a complication of a fractured skull. The particular form of meningitis known as Cerebro-spinal Fever, or Spotted Fever, occurs in the tropics, and in certain parts of Africa is prevalent amongst the natives. Due to infection which reaches the brain by way of the nose, tends to occur in epidemics, and is contracted by contact with the disease, from a healthy carrier, or from infected utensils, swabs, etc. It is not highly contagious.

The onset is usually sudden, with three constant symptoms, headache, fever, and vomiting; less constant are delirium and nasal catarrh. The headache, over the back of the head, is unusually severe and almost unrelieved by aspirin. Frequently begins with shivering and the temperature quickly rises to 102°–104° F.

After two or three days the patient resents interference and lies on his side with knees drawn up and his face away from the light: dislike of light a very marked feature. There is restlessness and mild delirium; the neck is stiff, as are the muscles generally, and the head is drawn backwards from the shoulders. In some cases a rash on body and limbs, but not always. By the end of a week, the patient is generally in a stupor and is beginning to lose flesh rapidly; neck and back muscles more rigid than ever, and fever still high, though with a tendency to fall. Pulse rapid but not always as high as might be expected from the temperature; much thirst and urine passed very frequently.

Without medical aid, the disease is likely to end fatally; a few make spontaneous recovery. If temperature and pulse return to normal and remain there for two weeks, complete recovery without relapses is likely, but stiffness in the muscles lasts several weeks.

Attendants should wear a mask of gauze over the nose and mouth. Burn swabs and use special crockery.

Apart from medical aid give careful nursing; 2 to 3 grains of calomel at the onset with 1 to 2 drachms of Epsom salts in the morning whenever necessary. In the later stages, when it is difficult to give anything by mouth, open the bowels with enema. Full light diet of fluids and

semi-solids from the onset, since later it may be difficult to feed by mouth. Cleanse the mouth frequently. Morphia will relieve headache when severe, $\frac{1}{6}$ grain hypodermically.

MOUNTAIN SICKNESS

Unpleasant symptoms affecting those who go too rapidly to a great altitude, particularly in the Andes or the Himalayas.

Rare below 10,000 feet; due to diminished pressure of oxygen. Onset often sudden with giddiness, headache, dislike of the light, nausea, and vomiting. May come on at once or some hours after arrival at high station. Fingers, lips, and ears become blue, with breathlessness. Milder symptoms follow on less rapid ascents: lassitude, loss of appetite and insomnia are some of them.

Limit exercise on first reaching 10,000 feet. Wait several days to allow time for acclimatization, then proceed with caution. In severe cases: rest in dark away from noise; give sweetened drinks only until vomiting stops, and 10 to 15 grains of aspirin to relieve headache. A high pillow beneath the shoulders at night, 1 tablet of Medinal, or 2 of Allonol, with a hot drink at night for persistent insomnia. Wear dark glasses.

Mountain sickness is not dangerous, but vomiting due to more serious causes (appendicitis, obstruction of the bowel, etc.) must not be overlooked in diagnosis.

MUMPS

An infectious disease with swelling of the salivary glands on either side. Apt to spread rapidly.

Sometimes fever at onset. The swelling usually first on one side, just below the ear, with pain. In a day or two the other side of the face affected. Swelling persists for about 10 days and then gradually subsides. In some cases about the eighth day, there is fever and malaise and the testicles become swollen and inflamed.

Rest in bed for a few days at the onset. Saline purgatives in the mornings as required. Diet of semi-solids, swallowed more easily than fluids. Highly spiced foods cause more pain. Apply kaolin poultices to the swelling if very painful. If the testicles become inflamed, wrap in cotton wool and support on a pillow in bed.

MYIASIS

Due to the larvae of flies parasitic in the body; may be cutaneous, nasal, or intestinal. Different species of flies may be concerned; in Africa the most important is the Tumbu fly, about the size of a small bluebottle, yellowish-grey. It lays its eggs on clothes; the larvae

burrow under the skin and produce small boils, with central opening from which black excrement of the larvae is exuded. The skin round the hole becomes inflamed and very itchy. Commonest in the forearm.

Small larvae can easily be squeezed out; when larger, make a small incision and extract with fine forceps. Chloroform may be injected into the maggot before this is done. Wash the wound with 1 in 20 carbolic and paint the skin around with tincture of iodine.

In Central and South America the Ver macaque or mosquito worm is the larva of another species which gets under the skin like the Tumbu fly. Treat as above.

The Screw-worm, also met with in America, is the larva of a fly which lays its eggs on the surface of wounds and in the ears and noses of persons sleeping in the open air, unless protected by a mosquito net. The maggots burrow into the tissue and in nasal infections penetrate to the sinuses and eat their way through to the brain. Treat by chloroform applications or inhalations. All wounds should be protected and kept clean, but if infected, should be treated with turpentine.

NOSE BLEEDING

For practical purposes regard the haemorrhage as coming from an artery near the front of the nasal septum, in which case it can always be stopped temporarily.

Take long strip of ribbon gauze, and with nasal forceps insert one end as far back into the nose as possible; then pack in the rest of the strip to the back of nose, working forwards, until it is filled with packing. Remove in 12 hours' time, when vein will have clotted and haemorrhage ceased. If handy apply first gauze soaked in 1 in 1000 adrenaline solution.

In severe cases much blood may be swallowed which will be vomited later. Do not be surprised if the motions passed during the next two days are black from swallowed blood.

PILES

The veins of the bowel varicose and dilated: fairly common, but liable to become worse in the tropics. Any sufferer should seek skilled advice before going abroad.

Internal piles lie inside the orifice of the bowel, but may come down on straining, particularly if constipated. They are then nipped by the muscle surrounding the opening and may swell up and become very painful and cause severe bleeding, and lead to anaemia.

Avoid constipation and if necessary take salts every morning (see Constipation). If the piles come down, they should be returned as soon as possible, and an ointment of galls and opium be applied to

relieve the pain. If the piles have remained down for long, apply cold packs before attempting to replace them.

External piles outside the orifice of the bowel do not bleed, but become inflamed and swollen from time to time and cause great pain. Relieve constipation, lie with hips raised, and apply hot fomentations frequently. If much pain and sleep is disturbed, give 15 grains of Dover's powder at night.

PLAGUE

There are two chief varieties, the bubonic and pneumonic. The disease, due to the *Bacillus pestis*, exists primarily as an infection in rats and in other rodents such as the Manchurian Marmot and the Californian Brown Squirrel and is transmitted to man by their fleas. The rat flea is chiefly concerned. Both the brown and black rat are liable to the disease and the latter is the more dangerous because it lives in closer association with man. When a rat dies of plague its fleas desert it, pass to other rats or to man, and spread the disease.

Pneumonic plague, although due to the same bacillus, is quite different, and is transmitted by droplets of sputum expelled in coughing, and probably also by the invisible spray which pneumonia patients discharge from the mouth.

Both forms of plague are characterized by sudden onset; sharp fever; giddiness; great weakness; a drunken gait, appearance, and speech; and a tendency to heart failure.

In bubonic plague there is lassitude, headache, and shivering, and the face is pale and anxious. The patient looks haggard, his eyes are often bloodshot, and his expression one of fear or horror. His temperature runs up to 102°, 104° F., or even higher, and his face gets hot and flushed. There is intense thirst, the tongue becomes dry and brown, the urine is scanty, and there may be delirium. About the second or third day the glandular swellings known as buboes appear, usually in the groin, but also in the armpits, the neck, and elsewhere. As a rule there is only one bubo; there may be much pain, sometimes very severe. The bubo, if not dealt with surgically, eventually softens and bursts, discharging matter and sloughs. Cases which are going to recover improve about the fourth or fifth day with profuse perspiration. In fatal cases death usually between the third and fifth day.

Pneumonic plague usually begins with shivering and vomiting: cough, breathlessness, and blueness of the face; the sputum is profuse, watery, and blood-stained: full of plague bacilli and exceedingly dangerous. Very few cases of pneumonic plague recover.

Avoid native houses and ward off fleas. Pesterine (kerosene 20 parts, soft soap 1 part, and water 5 parts), powdered naphthalene and tricresol

powder are all useful. Attendants should wear puttees or gumboots, gloves and overalls, and for pneumonic cases must wear masks, goggles, and overalls. Those travelling in districts where plague is endemic should be vaccinated against the disease.

The only treatment of any value, and this only in bubonic plague and when given early, is by plague antitoxin. Treat symptoms to relieve distress. Apply belladonna and glycerine to the buboes and, when suppuration is established, open and dress antiseptically: give morphia for restlessness and insomnia, and cardiac stimulants for the collapse.

PLEURISY

Inflammation of the membrane covering the lung, caused by exposure to cold and damp.

There is severe pain in one or other side of the chest, made worse at every breath. Frequently short, dry cough without expectoration, which aggravates the pain.

Going out into the cold from a warm tent tends to bring on the pain. In the early acute stages take to bed, and to relieve pain apply kaolin poultices to the chest on the side of the pain. When pain and cough are less severe, strap the chest on the sore side with overlapping strips of zinc oxide plaster running from 2 or 3 inches beyond the mid-line at the back round to 1 or 2 inches beyond the mid-line in front. As the strips are being applied, the patient empties the chest of air; this keeps the ribs fixed in a position of expiration. Give 15 grains of Dover's powder at night when pain very severe, and 1 drachm of Syrup of Codeine every four hours for a few doses to stop the cough.

PNEUMONIA

May attack both the traveller and his native attendants: the latter particularly liable to succumb. Caused by any conditions which lower the vitality: exposure to cold, chill, excessive alcohol, fatigue. Natives taken to cold climates should have sufficient blankets at night. If wet, make them get into dry clothing. Treat all sore throats promptly.

Onset is often sudden with shivering. Soon a short dry cough causes pain in one side of the chest. Later the cough more loose and a little blood-stained phlegm is coughed up. Temperature rises at once and the respiration rate is increased: shortness of breath, and lips, ears, and finger tips become blue. The face is flushed, the skin hot and dry, the tongue dry and coated with a brown fur and the lips cracked and sore. The pulse is full at first and the frequency slightly increased; later on it may become thin, running and rapid, and this is a bad sign.

The patient must go to bed at once, and never get out to attend to

his own toilet. Nurse in the most comfortable position, preferably lying flat, with a high pillow supporting the head and shoulders. This lifts the weight of the body off the chest and allows easy breathing.

Light diet, mostly of fluids and semi-solids; milk, eggs, and sweetened drinks, *i.e.* lemonade and orangeade with four tablespoonfuls of sugar to every pint. Half-ounce of brandy every four hours until the acute illness is over.

Open the bowels freely at first before the patient becomes too ill, by giving calomel, 2–3 grains at night, and magnesium sulphate, 2 drachms in half a tumbler of water the following morning.

Apply a poultice of hot kaolin spread on lint to the chest over the pain, and keep in position by a loose jacket or bandage. Tight bandages restrict movement of the chest, and are bad.

At night give chloral hydrate and potassium bromide, 15 grains of each, and if this does not give sleep, and there is much pain, 10–15 grains of Dover's powder. If pain at all severe, give $\frac{1}{6}$ grain of morphia by injection, but only in the early stages.

If cough at first troublesome and painful, give 1 drachm of linctus codeinae with a little warm water every three hours. If temperature rises above 104° F. or if the pulse becomes weak and rapid, sponge with tepid water, and in the latter case give stimulant drugs; the best is strychnine given hypodermically, but not more than $\frac{1}{16}$ grain every six hours.

At the end of about a week the illness reaches a crisis and the temperature falls to normal within 24 hours; keep in bed at least a week after this.

QUINSY

An abscess in one of the tonsils.

There is fever, headache, sore throat, and pain on swallowing. The pain may appear to shoot back into the ear. The tongue is coated and the breath foul. Enlarged glands may be found in the neck. A red swelling will be seen above one of the tonsils, which may be so large that it distorts the region.

Apply a hot kaolin poultice to the neck. Gargle with hot potassium permanganate, 1 grain to one pint of water, or with a hot salt solution, one drachm to one pint of water, every hour. At night give 10 grains of aspirin to relieve the pain, and an aperient.

RHEUMATISM

Acute rheumatism, or rheumatic fever, is a specific disease which often affects the heart. Cause is unknown, but the disease appears to be associated with a damp climate and often follows tonsilitis, which

may have been several weeks before. Relapses are always likely and may follow subsequent tonsilitis.

Symptoms are fever, which may be preceded by shivering; pains in the limbs and headache. One or more joints may become swollen and painful. The arthritis appears to pass from joint to joint. The pulse is rapid and regular, though of variable tension; the urine scanty and highly coloured. There is profuse perspiration, with peculiar sour odour. If the heart is badly affected, the patient will appear anxious and restless and will complain of pain over the heart.

Rest the affected heart; treat the painful joints; and give sodium salicylate.

Rest in bed, lying flat, between blankets, to rest the heart. If there is much anxiety and distress, nurse half propped up. Next attend to the joints. If the ankles and knees are affected, splint in the most comfortable position and relieve weight of the bedclothes by frame or cradle. Apply winter green oil on lint to the swollen joints, wrap them in cotton wool, and bandage lightly.

Make up a mixture of sodium salicylate 20 grains, sodium bicarbonate 20 grains, to every ounce of water, and give one ounce of this every two hours during the day and every three hours during the night until the acute fever and arthritis have subsided: then every four hours until temperature normal. Sometimes sodium salicylate causes delirium and vomiting; discontinue for a time and resume at less frequent intervals.

At the onset, pain must be relieved and sleep secured, by 10 grains of Dover's powder at night. Keep patient lying flat, and not allowed to feed himself or to attend to his toilet, until the fever has completely subsided. Careful nursing of great importance. Even when temperature normal, keep flat for at least three weeks. Then allow a single pillow, but if this sends up the pulse, resume recumbent position. Gradually assume sitting position by extra pillows. At the end of six weeks, the patient may sit up in a chair and then gradually begin to get about.

No severe exercise for many months.

RUPTURE

A protrusion of the bowel under the skin, usually in the groin. It can generally be pushed back into the belly, but reappears when the pressure is removed, especially when the patient coughs. Rupture should be cured by operation before going abroad.

For a rupture during travel, nothing more can be done until cured by operation or treated by fitting a truss. A simple rupture is not necessarily dangerous.

Strangulated rupture is a rupture which has become constricted so as to cause blockage or death of that part of the bowel; that occurs only in a comparatively small proportion of the cases: if unrelieved it is always fatal. The indications of strangulation are severe colicky pains in the belly, particularly round the navel, complete constipation, vomiting, and collapse. There are local pain and tenderness over the swelling.

Attempt to return the protrusion into the belly, but gently, and do not persist too long. Raise the hips on a pillow, bend the knees, and gently knead the swelling. If the first attempt fails, apply cold packs round the swelling for half an hour before renewing the attempt. If irreducible, summon surgical aid as quickly as possible. Purgatives must not be given.

SANDFLY FEVER

Also known as Phlebotomus Fever, is very widespread and probably occurs wherever sandflies are found.

The virus responsible is transmitted by sandflies or pappataci flies—tiny, hairy midges, which breed in heaps of damp stones, bricks, tiles, cracks in surface soil, walls of old cellars, cracks, and fissures in embankments, etc. These little flies are voracious blood suckers and feed principally at dusk and at dawn. They attack chiefly the wrists and ankles and can easily bite through thin socks or light cotton or linen clothes. During the day they hide in dark places; their bites are painful, and when numerous the bitten part may swell.

The fever is short and sharp and is often called three-day fever. The incubation period is four to seven days. The attack is sudden, beginning with chilly sensations and a tired feeling. The patient becomes giddy, has severe frontal headache with pain at the back of the eyes and pains in the back and legs. Rigors may occur. Very like influenza except that there is, as a rule, no catarrh. The face is flushed and the eyes are injected; there may be a sore throat and sometimes a little eruption on the throat or palate. The temperature rises rapidly and may attain 103° F. It remains up for about 24 hours and then begins to fall, usually normal on the third or fourth day. Sometimes there is a secondary rise of temperature. The patient may speedily recover, or convalescence may be tedious, with mental depression with digestion upset. Apparently never fatal, but troublesome and debilitating.

Protect from the bites of sandflies by a fine mesh net of 22 holes to the linear inch, of the same pattern as for malaria. Tobacco smoke keeps the flies away to some extent, and repellants are useful, especially vermajelli, containing some oil of citronella, sketofax, oil of cassia

and oil of eucalyptus. A lump of camphor in one's bed is useful as the flies dislike it. Keep sufferers under a fine net to prevent flies biting them and getting infected.

Rest in bed, light diet, and give one full dose of laudanum, *i.e.* 30 drops, as early as possible. Chlorodyne may also be used. Quinine is useless and may aggravate the symptoms. Aspirin and the salicylates are helpful. When there is much pain in the muscles, hot sandbags often give relief.

SCARLET FEVER

A disease of temperate climates: incubation period 2 to 4 days. Abrupt in onset with vomiting, headache, and sore throat. Skin hot and cheeks flushed. Temperature raised to 103° F. or more on first day, and pulse rapid. Tongue coated with red papillae showing through. Throat red, and glands in neck enlarged and tender. In mild cases rash is first sign.

Rash comes out on second day: first on upper part of chest, root of neck and upper arms; or sometimes first seen in armpits. Minute red spots on a rose-red skin blush. Area surrounding mouth not affected; so-called "circum oral pallor." Takes 3 to 4 days to develop, and spread over whole body. As rash fades temperature falls and skin begins to peel. Peeling takes 4 to 6 weeks. Last to peel are palms of hands and soles of feet.

Complications: include heart, kidney, and ear trouble, and are fairly common.

Isolate for 6 weeks or until peeling is complete, but longer if any discharge from nose or ears. Quarantine for contacts is 10 days. Confine to bed in well-ventilated place for 3 weeks from onset to avoid complications. Tepid sponging whenever fever reaches 103° F., and once daily as a routine. Attend to toilet of mouth. (See Nursing.) At onset give saline purgative: magnesium sulphate (Epsom salts) 2 drachms in half tumbler of water before breakfast. Repeat as required. During fever give milk and bland fluids only. When temperature falls increase to normal, but add meats and spiced foods last of all. For sore throat irrigate with hot permanganate lotion: 1 grain in half a pint of water. To do this use the Higginson's syringe or the infusion apparatus and insert the nozzle between the back teeth; head must be low and turned on side. If glands in neck are very tender apply poultices. (See Nursing.) To prevent kidney trouble give potassium citrate 20 grains, and sodium bicarbonate 20 grains in 1 oz. of water every four hours.

SCORPION STING AND SPIDER BITE

Scorpion sting is not infrequent in hot countries, but very rarely fatal to adult European unless several stings at one time. The usual symptoms in the adult are a brawny swelling in the skin and more or less collapse. There is often severe throbbing pain, and there may be vomiting.

Apply a tourniquet above the sting and incise the affected area; then apply an opium lotion. This usually affords relief and prevents extension of the swelling. A serum suitable for use in Egypt and the Sudan has been prepared, and when available should be used as soon as possible. It can be obtained in Cairo or in England from Messrs. Allen and Hanbury.

Spider bite may be important, some species having caused death. Some poisonous spiders are brightly coloured, their abdomens spotted with vermilion. In Peru there is the "pruning spider," also poisonous.

A red papule appears and there is sharp stinging pain. The papule is followed by spreading inflammation which, in rare instances, goes on to gangrene. The general symptoms are nervous exhaustion, high fever, rapid pulse, rapid breathing, and sometimes blood in the urine.

Apply a ligature and suck the wound. Use permanganate of potash locally, as in snake-bite. Give diffusible stimulants, such as ammonia, caffein, or camphor, and a strict milk diet during treatment.

SCURVY

Due to deficiency in vitamin C, found in fresh fruit and vegetables, and, to a lesser extent, in fresh meat and raw milk. Remember that there is a prescorbutic state, symptoms indefinite, which, if not recognized and promptly treated, will pass on into true scurvy.

Begins insidiously with progressive weakness, pallor, loss of weight, and stiffness in the leg muscles. Later the gums become affected, soft swellings sprouting up between the teeth. As the disease progresses, the gums become swollen and spongy, ulcerate and bleed and, in bad cases, the mouth may contain large fungating masses. Haemorrhages under the skin and mucous membrane and in the muscles are also found. Swelling of the legs is an important symptom, especially about the ankles. If untreated, the condition becomes worse, appetite is lost, mental depression sets in, there is breathlessness on exertion, and night and day blindness. Death results from heart failure or some complication.

Avoid by a good dietary, with sufficient antiscorbutic elements: fresh meat, vegetables, and fruit, or lemon and orange juice more potent than lime juice, the ration 1 oz. daily, with sugar. Dried peas

and beans develop vitamin C on being sprouted, and can be used on long journeys. Vegetables should never be overcooked nor soda used in boiling them. Canned fruits, as now prepared, may be used. For African native followers, Kaffir beer, made from germinated grain, is said to be of value: one pint daily per head. Potatoes, onions, and root vegetables are also useful: fresh meat is not so effective as either fruit or vegetables. Failing fresh food, take synthetic vitamin C (Redoxon tablets) 50 milligrams twice daily.

Cure is chiefly by diet of above foods. Keep in bed, have plenty of fresh air and avoid cold and damp. Clean the mouth with peroxide washes and touch the soft swellings of the gums with nitrate of silver solution, 2 per cent. Liberal diet, with plenty of fat, raw fresh eggs, and milk. Iron and cod liver oil are useful during convalescence.

SEA SICKNESS

A disorder of the central nervous system produced by unaccustomed stimulation of sense organs concerned with orientation in space, the eyes, the vestibular apparatus, and the bowels. May occur when the body is subject to continuous movement, as in train sickness and sea sickness, or sometimes when the body is stationary but objects around it are moving, as in watching the movements of the sea from the shore. Head symptoms comprise giddiness, double vision, headache, depression, and despondency, which may persist after going ashore. The gastric symptoms are nausea, retching and vomiting, the vomit ultimately thin bile-stained fluid. Appetite is completely lost, and constipation may be troublesome. The face is pale, the skin cold and clammy, and the pulse and respiration rates are quickened. Can be distinguished from appendicitis and intestinal obstruction, which require prompt treatment, by the absence of pain and a raised temperature. Death has never been known to occur from sea sickness.

Attend to constipation before going to sea. Secure a berth amidships. Eat two hours before going on board. Take potassium bromide grains 10–20 an hour before starting the voyage; or chloretone, 10 grains, or luminal, 2 grains.

Lie flat with the head low and keep warm. Give potassium bromide or chloretone, or both, in the above doses. Repeat in six hours if necessary. Insist on some food at regular intervals; small dry meals such as cold chicken and biscuits. Go on deck for a short time at the end of four hours. Attend to constipation. Give sodium bicarbonate, grains 10–20, every six hours while the vomiting lasts. Suck barley sugar or lump sugar between the attacks of sickness.

SKIN DISEASES

Chigger

A small sand flea which lives in dry sandy soil and sucks the blood of mammals, especially pigs. After impregnation the female burrows into the skin and swells as her eggs develop, causing inflammation and often suppuration of the sac. The skin may blister. Smarting or pricking sensation where the chigger is; later pain as the inflammation spreads; itching and redness.

Do not camp near native villages. Wash boots and shoes with a strong infusion of native tobacco; avoid walking barefoot.

Remove the flea with a clean sharp needle. If the swelling has formed, open and squeeze out, then wash with solution of carbolic or lysol.

Craw-Craw

A term used on West Coast of Africa for any papular or pustular eruption. Some are contagious and treated by opening up and washing with sublimate lotion, 1 in 1000, then dust with boric acid and zinc oxide.

Fungus Diseases

Ringworm of various sorts are very common in the tropics: usually between the toes, the groins, the upper parts of the thighs, and the armpits. Dhobie Itch is one.

Treat mild cases with ointment containing 2 drachms resorcin, salicylic acid 10 grains, vaseline 4 drachms, lanoline 4 drachms. An ointment of salicylic and benzoic acid, or one of ammoniated mercury, 2 to 5 per cent., may also be tried. For body ringworms, liniment of iodine useful, but some skins very sensitive to iodine; use with caution. For obstinate cases X-rays. Do not walk with bare feet on ship or on land.

Oriental Sore

Known as Baghdad Boil, Aleppo Button, Frontier Sore, Tropical Sore, etc. It occurs especially in Asia Minor, Arabia, Mesopotamia, and the north of India. Spread by sandflies: avoid being bitten.

Incubation from a fortnight to a year; may occur on any exposed part but most common on the forearms, hands, and face. Multiple sores are frequent. The first sign is a small, red, scaly papule, which grows and eventually breaks down, forming a painless ulcer with a hard dry edge: also non-ulcerating forms. Healing usually from six to twelve months, leaving a white or pink scar.

Many drugs have been advised. Intravenous injection of tartar

emetic, only by a doctor. A 2 per cent. ointment of tartrate of antimony sometimes useful. Seek medical advice.

Prickly Heat

Very frequent, especially in the moist tropics: due to excessive sweating and accompanied by intense heat and itching. The skin covered with many slightly inflamed papules, set close together; may remain for months.

Avoid excessive perspiration. Wash in the bath with carbolic soap and dust with equal parts of boric acid, zinc oxide, and starch. Change underclothing daily and keep skin as dry as possible.

Ulcers in the Tropics

Often very troublesome. Want of sufficient animal food greatly favours their development. Rest is essential for cure. If unhealthy, wash well with carbolic acid, 1 in 40, dust with iodoform, and cover with lint moistened with carbolic oil or smeared with iodoform ointment.

Tropical Ulcer

A special and serious form found chiefly on the lower part of the leg and about the foot and ankle.

Starts as a small, tender, and often itchy, papular bleb, surrounded by a dense inflammatory zone; this soon breaks down and forms an ulcer which spreads and destroys the tissues. It may be mistaken for a syphilitic ulcer, but does not yield to anti-syphilitic remedies.

Prolonged rest in bed is necessary. As a palliative, before it is possible to lie up, wash with antiseptic such as carbolic lotion, and apply iodoform ointment.

Veldt Sore

Also known as Barcoo rot; common in hot, dry climates, such as Egypt, Palestine, South Africa, and Mesopotamia. Apt to occur in debilitated persons not receiving proper food. The sores are commonest on the hands and forearms. They begin as itchy papules which become blebs, then pustules, and finally ulcers. They are usually multiple, and when they heal they leave areas of thin, glossy skin.

Prophylaxis, as for boils. Check spread of the ulcers by pulling out the hairs from the bases and round the margins. Wash with a 1·5 per cent. sodium citrate and 20 per cent. common salt solution. Vaccines and Stannoxyl, as used for boils, may be employed. Wash the sores with carbolic acid solution; and a salicylic ointment, 10 to 20 grains to the ounce, has given good results.

SMALLPOX

Prevalent in the tropics: incubation 12 days. Rash appears on third day.

Abrupt onset with shivering followed by severe pains in limbs and loins, headache, nausea, vomiting and delirium, loss of appetite, thirst, and constipation. Skin hot and dry, tongue heavily coated, and temperature raised to 104° F. or more on first day. Rash appears on third day beginning on forehead, temples, face, and limbs; spreads to trunk. Uncovered parts and those exposed to pressure most affected, *i.e.* face, hands, wrists, and back; armpits and groins usually spared. At first small red raised spots with characteristic "shotty" feel; appear to be in skin rather than upon it. (See Chicken pox.) About third day of rash small blebs form at centre of spots which at first are transparent but soon come to contain yellow matter. By sixth day these pustules become depressed at their centre; soon they break down and discharge matter which forms a scab under which the skin heals, leaving a scar. Usually there are two peaks of fever, first on the appearance of rash, then at the stage of pustulation. The rash may affect the eyes, the throat, and roof of the mouth. Face is often much swollen as result of the rash.

Complications arise from involvement of eyes. Bed sores form easily. Glands in neck may be swollen.

Before starting, re-vaccination is always advisable if not already done within last three years. When smallpox breaks out: (1) isolate the patient; (2) burn all his clothing, bedding, etc., and allow nobody to use the tent or hut in which he has been living; (3) vaccinate or re-vaccinate all contacts as soon as possible; effective if done within four days or even longer after exposure; (4) quarantine for contacts is 16 days.

Nurse in bed in a cool airy place; tepid sponging night and morning; attention to toilet of mouth. For constipation give 2 drachms of Epsom salts (magnesium sulphate) every morning as required, in half a glass of water. Irrigate the nose with solution of sodium chloride (common salt), 1 drachm in a pint of water once a day; use a small dropper. Then instil two or three drops of liquid paraffin up each nostril. Irrigate the eyes once a day with boracic lotion. Diet should be milk and bland fluids only while there is fever; later it can be increased to normal. If vomiting is intractable, substitute iced drinks and give 5 minims of tincture of iodine, well diluted. For sleeplessness, delirium, and headache, give 10 grains of Dover's powder and repeat in 6 hours' time, when necessary. Aspirin 10 grains or chloral 10–15 grains are useful alternatives. When eruption is thick on the scalp, cut the hair short. A saturated solution of potassium permanganate

may be painted over the body twice daily where the rash is thickest: poultice very inflamed pocks. For laryngitis, give steam inhalations. When pulse weak and rapid inject $\frac{1}{16}$ grain of strychnine, and repeat if necessary in four hours' time. (See also Nursing.)

Infectious until all scabs have separated and skin is quite healed. A special attendant should nurse throughout the illness; live apart from others; and always wear a gown or special clothing when at his duties, which must be burnt at the end of the illness.

During an epidemic of smallpox it may become necessary to vaccinate contacts and early cases. Cleanse the outer side of the upper arm with spirit. Blow out one drop of lymph from the tube on to skin. With a needle which has been sterilized by heating it in a flame make one scratch through the lymph on the skin $\frac{1}{4}$ inch long: this should break the surface but not draw blood. Allow lymph to dry, then cover with boric lint held in place by strapping. If successful a raised blob appears at the end of 1 week; a dry scab should separate in about 3 weeks. Sometimes the reaction is severe, the arm becoming red and swollen locally and the glands in that armpit painful and large. When arm is inflamed apply hot fomentations, carry it in a sling or take to bed. Give aspirin 10 grains for pain.

SNAKE-BITE

Poisonous snakes are conveniently classified by the action of their venom.

Colubrine venom acts mainly upon nervous system causing paralysis, particularly of respiration. Snakes have narrow heads, tapering pointed tails, fangs are short and grooved in front only. They strike more slowly and less effectively than viperines and their venom takes longer to act. Best known members of the species are cobras and kraits.

Viperine venom attacks mainly the vascular system, causing clotting in the blood vessels and bleeding into the tissues. Snakes have broad, wedge-shaped heads, short blunt tails, fangs long and canalized. Well-known species are: Russell's viper, the rattlesnake, and the European vipers.

Severity depends upon the amount of venom injected. Colubrine bites cause pain in the part, which becomes very swollen. After about an hour the victim becomes dull, apathetic, and unable to stand. Soon there is nausea and vomiting with much salivation followed by paralysis of tongue and larynx. Eventually respiration becomes paralysed causing death. If victim survives paralysis, he is likely to recover quickly. Viperine bites cause severe pain, swelling and bruising of the part, soon followed by collapse with nausea, vomiting, and a weak

running pulse which leads to coma. On recovery from collapse victim has a wound with extensive suppuration. Often blood is passed in the urine and the motions.

Treatment must be prompt to be effective. Objects are to prevent absorption of poison and to neutralize toxic effects.

Tie a ligature tightly round the limb above the bite to obliterate arterial pulse: place it so that main artery to limb is compressed against a single bone; *i.e.* round the thigh if foot or leg has been bitten; round the arm if it is the hand or forearm. If a finger has been bitten, tie a second ligature round it above the bite. If handy use a stout piece of rubber tubing; failing this a strip of torn-up clothing. To tighten insert a stick between ligature and skin, then twist. After every 20 minutes loosen the ligature for 30 seconds to flush the limb with blood. Wash the wound and wipe clean as soon as ligature is in place and before incisions are made, otherwise more poison will be absorbed. Cut away the bitten area with a knife and wash out the wound left with a strong solution of potassium permanganate (2 grains in half a cupful of water) then suck the wound and expectorate. After sucking venom from wound wash the mouth out with permanganate once or twice. The permanganate may also be injected locally round the wound, but this should be reserved for severe bites, since it causes sloughing and death of the tissues. Repeat application of permanganate and suction every time the ligature has been loosened for 30 seconds. Keep the victim warm and at rest. Give black coffee and inhalations of aromatic ammonia (sal volatile). If handy give an injection of 5 to 10 minims of adrenalin or $\frac{1}{2}$ cubic centimetre of pituitrin. Do not give strychnine or alcohol. If the patient cannot swallow keep the head low and when he vomits swab out the throat, using gauze tied on to sticks or gripped in forceps, to prevent vomited material from reaching the lungs. If respiration is paralysed do artificial respiration. If throat is paralysed food may pass into lungs instead of stomach, so withhold food or give fluids through a stomach tube. (See Nursing.)

SNOW BLINDNESS

Due to exposure of eyes to much ultra violet radiation as happens in snowy regions, at sea on a bright day, in the desert, and at great altitudes. In these places always wear dark glasses: frames containing tinted Crookes' glass are suitable.

Some hours after exposure the eyes begin to smart and water. Pain may be very severe causing headache and sleeplessness. Symptoms last for days or weeks according to severity of exposure.

Try inserting one tablet of $\frac{1}{20}$ grain of cocaine beneath the lower lid

(see Eyes). In mild cases insert 1 drop of 1 in 1000 adrenaline solution. Wear very dark glasses, or keep the eyes bandaged until pain and watering have gone. Give Dover's powder 10 grains at night to secure sleep, or an injection of morphia $\frac{1}{6}$ grain in very bad cases. Be particularly careful to avoid further exposure.

SUN STROKE

Caused by exposure to high atmospheric temperature, particularly to the sun in tropical climates, but it is possible to get sun stroke even under shelter if temperature sufficiently high; may occur on board ship among stokers. Very damp heat particularly dangerous as it prevents cooling by sweating. There is no evidence that the rays of the sun, other than heat rays, cause sun stroke. A shade temperature of 110° F. dangerous.

Symptoms may not come on until the evening or the morning following exposure. Various types of illness occur.

Heat exhaustion is comparatively mild: there is weakness, giddiness, faintness, and inability to walk. The temperature rises to 102° or 103° F. for two or three days and the pulse becomes rapid and weak.

Heat hyperpyrexia is more serious: onset sudden with headache, restlessness, nausea, and vomiting. Temperature rises suddenly to 110° F. or more, and there may be convulsions, delirium, and coma. With recovery the temperature remains high, 102° or 103° F., for several days. For several weeks there is great liability to relapse; take the utmost care to avoid re-exposure to the heat. In some cases nausea and vomiting may be the outstanding symptoms; in others, the so-called choleraic type, vomiting and diarrhoea are the most marked, the latter very grave.

Protect the head with a sun-helmet or a double terai hat in hot climates. Or a white handkerchief crumpled up into the crown of any hat will give some protection. For use of aluminium foil see pp. 25, 88.

Tents, of a white material fitted with a fly, should be kept closed during the day and open at night.

Avoid severe exercise in the heat of the day. Avoid alcohol, but drink plenty of water. Heat-producing foods, such as meat, in moderation.

For heat exhaustion remove the patient to the shade, put him to bed, and give a saline aperient, such as Epsom salts, in doses of 1 to 3 drachms every morning. Keep him in bed for several days after the temperature has returned to normal.

In cases of high fever in the tropics remember the possibility of malaria. In doubt give quinine. (*v.* Malaria.) When temperature above 104° F. place the patient upon a wet sheet and sprinkle cold, or better,

iced water over his body. Fit a fan or punka to assist evaporation from the skin. Meanwhile apply wet packs to the head frequently. Give cold or iced water enemas, and if the patient is very restless or is having convulsions, add 30 grains of chloral hydrate with 30 grains of potassium bromide to the first ½ pint of the fluid run in. (See Nursing.)

In very high fever, put the patient on a sheet or blanket and lift him upon this into a cold bath; leave there for 10 to 15 minutes, but if he begins to shiver remove him from it. Place a thermometer in the bowel and when temperature falls to 102° F. stop these cooling measures, dab all over with a dry towel, and wrap in a dry blanket. Keep warm with hot water bottles. Stimulants may now be given, 1 oz. of brandy in a little water, or hot coffee, by mouth.

Watch the pulse and if it becomes weak, give stimulants without delay: not strychnine, but 1 cubic centimetre of the subcutaneous preparation of coramine hypodermically.

If vomiting is marked give 30 grains of sodium bicarbonate and two teaspoonfuls of glucose in ½ pint of water every two hours by mouth; this should reduce temperature and bring on sweating.

Remember that after sun stroke sweating may be in abeyance for a month or longer; for this reason take the very greatest care to protect from heat for many months.

TICK FEVER

A form of relapsing fever produced by the bite of a bug-like tick, common in some parts of Africa (see p. 411).

The tick lives in native houses and rest-houses, especially along caravan routes; concealed in cracks and corners of the walls and mud floors, it bites at night only. The bite is painful, and the infected excreta of the tick contaminate the bite. One tick can cause the infection.

The chief symptoms are shivering, pains in the back and limbs, rapid pulse, and sometimes severe vomiting and diarrhoea, frontal headache, and painful, bloodshot eyes. The fever, of the relapsing type, generally lasts about a week; there may be an interval without fever for a few days, followed by another attack. There are usually several relapses. Iritis is a troublesome complication.

Avoid sleeping in native huts and rest-houses which have been occupied by natives. Do not sleep on the ground or in wooden native bedsteads. In badly infested places use a hammock. A mosquito net keeps the ticks out, and night-lights are also said to keep them away. Inspect packs and blankets periodically to see that they do not harbour ticks. If one has to camp on an infected area, fire the ground, dig up the cow-dung floors of huts, remove and bury or treat with fire,

seeing that the ticks do not escape. Wandering ticks can be kept away from a tent to some extent by digging a trench round it and filling it with wood ashes. Since the cow-dung mud rest-houses have been replaced by modern buildings with concrete floors, there is far less chance of being bitten by ticks than there used to be.

Careful nursing, a light diet, and strict rest in bed are essential. If a doctor is available, inject one of the salvarsan group of arsenicals. Heart stimulants may be required.

TRYPANOSOMIASIS (Sleeping sickness)

Caused by a small parasite inoculated into the blood by the bites of tsetse flies: limited to Equatorial Africa.

Two species of tsetse flies to be considered, *Glossina morsitans* and *Glossina palpalis*. The former occurs in thin deciduous bush, or low comparatively open forest; the latter haunts the neighbourhood of trees and lakes and is very rarely found far from water. These flies are about the size of a small blue-bottle, but not so stoutly built, and their wings, when closed, overlap and project beyond the end of the abdomen. *G. morsitans* is brownish, with bands on its abdomen. *G. palpalis* is much darker, almost black. Both have a quick and darting flight, and are attracted by rapidly moving objects, such as motor bicycles and motor cars. They bite only during the day, or on bright moonlight nights.

Incubation period about ten days. The bite may be painful with an inflammatory reaction. Fever, the first sign, is irregular, and tends to come and go. Then the glands in the neck and other areas of the body become enlarged and may be tender. A rash, only seen on white skins and not on the dark skin of natives, may appear; large rose-red rings which fade on pressure, special to the disease. Headaches, and the spleen enlarges. At this stage distinguish from malarial fever by finding trypanosomes in the blood, microscopically. If not treated the disease may run an acute or chronic course, with a gradual deterioration of the health, and finally with nervous symptoms developing (sleeping sickness). The patient then becomes dull and drowsy, speech and movements are affected, the face gets puffy, and he shuffles when he walks; fever continues and emaciation often extreme. Gradually a sleepy condition develops, better described as deep lethargy. Saliva dribbles from the lips and half-masticated food may remain in the mouth. Finally the patient becomes helpless, indifferent to his surroundings, and dies in coma.

To avoid being bitten by tsetse flies is by no means simple. When passing through fly belts in infected areas, wear veils and gloves. Unless it is absolutely necessary to pass through such places, avoid them strictly.

Two drugs are now used to treat trypanosomiasis, Bayer "205," non-arsenical, and tryparsamide, arsenical. These drugs are given intravenously, over ten weeks or more, only by a medical man.

TYPHOID FEVER: See Enteric.

TYPHUS FEVER

The usual form is less common in the tropics than in certain sub-tropical countries, such as Egypt. Lately special tropical varieties have been described, the carriers in these cases not lice, as in the ordinary form, but fleas, mites, and ticks.

Incubation 5 to 14 days, as a rule 12. The first symptoms like influenza. The patient is feverish and uncomfortable, on the third day the typical symptoms appear. The face then becomes flushed, the eyes congested, the pulse rate increases, and the temperature runs up to 103° or 104° F. A rash appears on the fifth day; described as a mulberry rash, most profuse on the trunk, especially on the back. With its appearance the patient becomes seriously ill and all the symptoms are intensified. During the second week, prostration becomes more marked; there may be delirium, and the patient lies on his back with a dull, expressionless face, flushed cheeks, sordes accumulate on the teeth, and a mousy odour emanates from the body. In cases that are going to recover, the fever falls by crisis on the 12th or 14th day, the condition then improves and the patient, though weak, awakes from his stupor and the mind clears. Convalescence is rapid and relapses are very rare. Of common complications, broncho-pneumonia is the chief.

Destroy lice by the methods of p. 410. Nurses should be protected from lice by overalls, etc., and the patients themselves thoroughly cleansed, their hair cut or shaved and completely deloused. Disinfect bedding and clothing.

Good nursing is more important than drugs. Keep the mouth clean and give nourishing soups, glucose water, milk, beef tea, and plenty of water. If constipated, give enema. Fresh air, as much as possible, is valuable; and if the heart is failing, stimulants such as alcohol, digitalis, or strophanthus.

In tropical typhus (urban and rural), the symptoms are allied to those of ordinary typhus, but the fever is generally less severe and the rash often less conspicuous; sometimes it may be absent.

UNDULANT FEVER

Formerly called Malta fever, is caused by a small bacterium in the blood and tissues, nearly always conveyed by drinking infected goats'

milk. Goats have the disease in a latent form, harbour the organism, and excrete it in their milk, urine, etc. Cream ices made from milk, and cheeses may be contaminated. The disease occurs in the Mediterranean littoral and in other parts of the sub-tropics and tropics. A similar organism found in cows causes abortus fever.

Symptoms are the same in the two varieties. After incubation of five to fifteen days, begins with headache, malaise, anorexia, and sleeplessness; usually constipation, and tenderness about the spleen, which is enlarged at an early date. Temperature rises by steps for three or four days, and then falls by similar descent, reaching normal on or about the tenth day. At this early stage bleeding from the nose may occur and profuse night sweats are not uncommon. The tongue is flabby and coated. When the temperature falls the patient feels better for a few days, but is still apt to suffer from night sweats, and continues to lose flesh. A relapse, with joint troubles and sometimes neuralgic pains, soon follows, and then a series of fever waves at short intervals: last sixty to seventy days, even nearly a year. The death rate is low, only some 2 per cent. The long illness causes anaemia and often mental depression. Irregular forms of the disease are diagnosed by laboratory blood tests. Any one suffering from prolonged fever of unknown origin should have the blood tested against both undulant and abortus fever: the latter form often occurs in England.

Avoid drinking goats' milk and eating its products. If goats' milk must be drunk it must be boiled. General hygienic measures important; remember that the organism is found in the patient's urine, which should therefore be disinfected.

Medical attention and good nursing are essential: vaccine should be administered only under medical supervision. Sedatives for the joint pains and neuralgia, and hypnotics for sleeplessness which is often troublesome.

URINE, RETENTION OF

Unlikely to affect travellers, except after a spinal injury. The full bladder is felt as a tense swelling in the lower part of the belly. In spinal cases the patient cannot tell when his bladder is full, so examine the abdomen every 3 hours to see whether the bladder can be felt. When it is becoming tense attempt to express the urine from it by firm pressure with the flat of the hand downward and backward. When the bladder is felt as high up in the belly as the navel it is getting very full; it should be emptied before it reaches as high as that. Do not pass a catheter in these cases because of the danger of infecting the bladder and kidneys, for even if nothing at all is done urine sooner or later will overflow of its own accord from the very full bladder.

In other cases first sit patient in a warm bath when urine may be passed naturally. If this fails repeat, 20 min. after giving an injection of $\frac{1}{16}$ grain morphia and $\frac{1}{200}$ grain of atropine. As a last resort try to pass the catheter. To do this boil the catheter for five minutes, lubricate it with sterile paraffin or vaseline, and introduce the closed end into the opening of the pipe. Next hold the pipe out at right angles to the body while the catheter is pushed gently down it until it will go no farther. While still pushing on the catheter and pulling on the pipe move the latter through a right angle until it comes to lie between the legs. At this stage the catheter should enter the bladder. It is unlikely that the passage of a catheter will ever be necessary, so do not attempt it except as a last resort.

VINCENT'S ANGINA

Sore throat, with ulceration, due to specific micro-organisms of Vincent. Rare in adults except under debilitating conditions: exposure, dirt, inadequate diet.

Mild fever, sore throat and sometimes enlarged glands in neck. Throat ulcerated and covered with membrane as in diphtheria; usually on tonsil, inside cheeks and round gums. Almost always unilateral, whereas diphtheria often bilateral and not on cheeks and gums. Pulse not rapid and glands never very large as in diphtheria. If in doubt regard as diphtheria, but in both treat sore throat as follows:

Cleanse with mouth wash after meals, then paint ulcers with tincture of iodine, or better Mandl's paint. Correct a faulty diet, and give halibut liver oil 3 drops thrice daily, and fresh lemon juice (or Redoxon 1 tablet thrice daily) (see Diphtheria).

WOUNDS

Before treating a wound sterilize instruments by boiling for ten minutes, except sharp instruments like knives; place these for 20 minutes in spirit or in pure Lysol, but rinse in boiled water before use. Ligature materials like cat-gut and fishing-gut are kept in spirit within sealed glass containers, thus sterile and ready for use. Soak for one minute in warm boiled water to make pliable. Sterile dressings in sealed paper packets must be preserved intact until they are wanted. See that all instruments and dressings are ready before proceeding.

Cleanse the hands thoroughly by washing them for at least five minutes with soap and running water. Once this is done touch nothing that is unsterile. These measures are of great importance: carry out as conscientiously as circumstances permit.

First aid consists in immediate arrest of haemorrhage, removal of obvious dirt from the wound, and covering it with any available

dressing (a clean handkerchief is better than nothing). If there is shock keep the patient warm, see that he is moved about and exposed as little as possible, and when there is much pain give $\frac{1}{6}$ of a grain of morphia hypodermically. Hot coffee or tea is a good stimulant.

First examine wound to discover extent of injury. Plug with sterile gauze soaked in a solution of flavine 1 in 1000 (1 tablet in half a pint of boiled water), or Dettol, then clean surrounding skin with soap and water, wash away the soap, and dab dry. Cut away dead and damaged tissue, remove foreign bodies and dirt, ligature bleeding vessels, and examine for fracture of underlying bone. (See Haemorrhage; Fractures.) Next decide whether wound should be closed or left open to drain away infected material. If it has been possible to clean it up within a few hours, and if tissues not crushed, swab out with flavine, or solution potassium permanganate (1 grain in half a pint of sterile water) and sew up with interrupted stitches. Should infection then ensue instead of clean healing, remove one or more of the stitches to allow drainage of matter. If wound is near a joint splint it to prevent movement. When a wound is obviously infected, or has not been attended to until several hours after the accident, leave it open and pack daily with gauze soaked in flavine solution. If at the end of 48 hours it is clear of matter and looks healthy, continue by dressing daily with dry sterile gauze. When there is much redness and swelling of the surrounding skin, soak the whole limb for at least ten minutes thrice daily in a hot saline bath (2 drachms of salt, sodium chloride, to 1 pint of sterile water) until the inflammation has subsided. Antiseptic lotions other than flavine may be used: Dettol, weak Lysol, and Eusol.

In wounds which have been left open and allowed to heal without suture, a raw pink area which bleeds easily (granulations) sometimes remains projecting between the skin edges and prevents proper healing. Touch these granulations lightly on the surface every day with silver nitrate stick to cauterize them. This causes no pain.

Treat small infected wounds, like burst boils and carbuncles, by a dressing of magnesium sulphate paste on gauze for 24 to 48 hours. This prevents the spread of infected matter to healthy areas. It causes pain, so aspirin 10 grains may have to be given to secure sleep at night.

WORMS

Worms are introduced chiefly by dirty water or imperfectly cooked food. Bilharzia is acquired by wading or washing in water in which infected snails are living. A parasite escapes from the snail and penetrates the skin. In the case of hookworms (ancylostomes) soil contaminated with the embryos is the chief medium of infection.

Worms are divided into two main groups, flat worms (trematodes

and cestodes) and round worms (nematodes). Trematodes or flukes live in the bile ducts or in the intestine. Cestodes or tape worms and nematodes or round worms in the intestine. The following is an account of some of the more important of these.

The Bilharzia worm, of which there are two species, produces Bilharziasis or Schistosomiasis in various parts of the world, especially in Egypt. The worms live in parts of the human vascular system, where they produce their eggs, furnished with spines, which irritate the tissues when they pass into the bladder or rectum. In the urinary form the eggs have a terminal spine, in the intestinal form a lateral one. Passed either in the urine or excreta to water, where they produce a larva which enters water snails. Development now takes place, the final product being a number of small forms known as cercariae which erupt from the tissues of the snail and swim about in the water. They can penetrate the unbroken skin or intact mucous membrane and so enter any one who is drinking, wading, or bathing in the water. From the skin they pass to the liver, and thence on to the portal vein and its radicles where they live.

In the urinary form the chief symptom is the passage of blood in the urine, with irritation of the bladder and urethra. In the intestinal form symptoms resemble dysentery, with blood and mucus in the motions.

Carefully avoid water which may be infected. Bathing, wading, washing in, or drinking such waters are all dangerous. Wherever possible boil water which may be infected. If this cannot be done, use sodium bisulphate tablets; two of the 16-grain water-purifying tablets to a quart bottle of water are efficient. Filtration through a Pasteur-Chamberland or Doulton candle excludes the *cercariae*. Bath water can be rendered safe for immediate use by adding undiluted Army cresol, 1 part in 10,000. If water is kept overnight, 1 in 90,000 is sufficient, as storage tends to diminish infection.

Cure by intravenous injections of antimony or some of its preparations, such as Fouadin (intramuscularly), but only by a doctor. If medical attention is unobtainable, some relief by urotropin and sedative drugs.

TAPE WORMS may measure many feet, and their presence detected only by finding the segments in the motions. Sometimes vague symptoms such as indigestion and an abnormal appetite may be felt.

Starve for two days; on the morning of the third day, after a dose of salts the previous evening, give 3 capsules of liquid extract of male fern (60 minims or drops in each), one at 9 a.m., one at 9.20, and one

at 9.40. At 10 a.m. give magnesium sulphate 1 oz. (not castor oil). This will bring away large masses of the worm, but unless the head comes away as well, the parasite will regenerate itself and segments will appear in the motions again, some three months later. If capsules are not available give the liquid extract of fern in an ounce of gruel or milk. Oil of turpentine in 30 minim doses is also useful.

HOOKWORM is the American name for one of the ancylostomes which infect man. The disease they cause, ancylostomiasis, is common, especially in the tropics. It chiefly affects natives, owing to their habits, but occurs also in Europeans.

Hookworms are small, almost cylindrical worms, which inhabit the upper parts of the human small intestine, to the wall of which they attach themselves by their mouths, which are furnished with formidable hooks and lancets. They feed on the mucous membrane and damage the small blood vessels which bleed into the bowel. At the same time they give off a toxin which helps to cause the clinical symptoms. The eggs of the worm are passed in the excrement and develop in the soil into larvae, which can penetrate unbroken skin. This is the most important route of infection, but it may come by drinking water and from contaminated food.

The most marked symptom is anaemia, often associated with digestive troubles. Palpitation of the heart and shortness of breath are frequent. In bad cases the appetite is disordered or depraved, and there may be swelling chiefly about the face and ankles; the face is frequently puffy and the skin assumes a peculiar, earthy hue. In children the disease leads to malnutrition and maldevelopment, and they often become pot-bellied. Ground itch often precedes the symptoms: this is a skin eruption like eczema, usually on the feet and legs, caused by the larvae penetrating the skin.

Prevent contamination of the soil by infected excrement. When camping, make proper latrines. Prevent the fouling of water and foodstuffs, such as vegetables which are eaten uncooked. It is very dangerous to go barefoot where the disease occurs and camping sites should always be thoroughly cleansed.

Curative.—Efficient treatment only with microscopic examination of the stools. Many medicines are employed as vermifuges; the chief are thymol, oil of chenopodium, carbon tetrachloride, β naphthol, and oil of eucalyptus: these drugs administered only under careful medical supervision. The anaemia must be treated; for natives a nutritious and easily digested diet is recommended: bread 1 lb., milk 2 pints, sugar 2 oz., 2 eggs and 4 bananas daily. Treat ground itch with ointment of zinc oxide and salicylic acid.

ROUND WORM resembles the garden worm, is several inches long. It is sometimes vomited, but more commonly is seen in the motions. Causes minor abdominal symptoms. Treat by santonin, 2 to 5 grains, in a little milk repeated every second day for three doses. On the alternate days the bowels should be freely opened. Carbon tetrachloride and some of the other anthelminthics are also effective.

THREAD WORM is a small, round worm, about half an inch long, which inhabits the lower end of the bowel and causes great heat and itching about the anus, especially at night.

Wash out the lower bowel and inject about half a pint of tea, or a similar quantity of water containing 1 teaspoonful of salt, tannin, or alum; then apply a little mercurial ointment (blue ointment) round the anus to diminish the irritation, every third day until the worms have disappeared from the motions.

GUINEA WORM often measures 1 ft. or more; it chiefly causes trouble in the feet, ankles, and legs, where, to escape from the body, it penetrates the skin, causing a small ulcer. The larvae which escape pass into water, when the patient wades or washes, and develop in water fleas. Infection results from swallowing them. Inflammation and pus frequent along the track of the worm.

Keep infected persons away from water supplies and wells, and protect water holes. In areas where guinea worm occurs, boil all water, or filter through clean cotton cloth to remove the small water fleas in which the larva develops. Or treat infected water by potassium permanganate, 1 oz. to every 2000 gallons of well water. Caustic potash and quicklime are also effective.

When the worm can be seen at the base of the little ulcer, secure it to a match and wind out a small portion daily on this. Gradually it comes away after its uterus is emptied of the young embryos and the whole worm may thus be removed. Attempts to draw it out forcibly break it in the tissue and violent inflammation will result, necessitating free incisions in the limb. While the worm is being wound out, keep the part around very clean, and apply antiseptic ointment.

YELLOW FEVER

Known only in parts of the New World and on the West Coast of Africa. One attack confers immunity. Caused by a filterable virus which, present in the blood during the first two days of the disease, is carried by mosquitoes from man to man.

The onset is very sudden, the highest temperature being reached almost at once. This remains high for four days or more, then drops

(the stage of remission or calm) and the attack either terminates here or the temperature rises again (the relapse). Some of the symptoms resemble malaria, but the rapidity of the onset, severe pain in the forehead, eyes and loins, the early scantiness of the urine, the marked jaundice, the bright eyes, the narrow red tongue and the absence of pain about the spleen are fairly characteristic. The jaundice develops about the third day and tends to increase. The urine contains much albumin and suppression of urine may occur. There is considerable thirst and vomiting, and in bad cases the vomit becomes black (black vomit) from altered blood which has oozed out into the stomach.

An important diagnostic feature is that the pulse becomes slow and does not rise again with the temperature during the relapse (Faget's sign).

Avoid being bitten by mosquitoes (see pp. 409, 414). Remember that *Aëdes aegypti*, unlike anopheline mosquitoes, bites during the day. It usually breeds near houses. Abolish, or protect with mosquito netting any vessel holding water; it is remarkable in what small quantities of water they will lay their eggs. Patients must be isolated and kept under a mosquito net or in a mosquito proof chamber to prevent them from infecting mosquitoes, which they may in the early stages. A protective inoculation should be administered to all going to yellow fever countries. Enquire at the Wellcome Bureau of Scientific Research in London.

Open the bowels by calomel, 5 grains, followed by a saline purge and hot water enema. Some prefer castor oil. Give 10 grains of bicarbonate of soda three times a day and cooling drinks such as fruit salt. Fluids should be pressed, as they help to wash the toxin out of the system. Add glucose to such drinks. Hot fomentations to the back and mustard leaves to the pit of the stomach are useful where vomiting is troublesome. Immune serum from a case that has suffered from yellow fever, if available, may be injected.

During the first two or three days of the fever the patient is better without any food at all, or may be kept going with sips of glucose water. As he recovers his appetite returns and only the plainest and simplest foods in very small quantities should be permitted, the amounts gradually increased, or relapses may occur. Stimulants are usually required in the later stages, but employ carefully as they may increase the vomiting.

MEDICAL STORES

FIRST AID

In addition to the main medical stores keep a small first-aid dressing case close at hand for emergencies. The case should contain:

Instruments: A scalpel; 2 Spencer-Wells artery forceps; plain forceps; probe; aneurism needle; eye spud; surgical thread, or fishing-gut ligatures; clinical thermometer in metal case; metal hypodermic syringe with spare needles; a packet of suture needles (assorted shapes and sizes).

Dressings: Compressed bandages; boric lint; sterile gauze;

Drugs: tube of morphia tablets ($\frac{1}{6}$ grain each); potassium permanganate tablets; small phial of tincture of iodine mitis.

MEDICINES

The following short list of medicines is intended as a guide to the preparations most generally useful. In certain tropical regions additional drugs may be wanted; consult also p. 379 and sections on diseases.

ADRENALINE: Constricts small blood vessels. For conjunctivitis, snow-blindness, nose bleeding, etc. Use 1 in 1000 solution.

AMMONIA: Stimulant. For fainting and collapse. Crush an ampoule of aromatic ammonia (sal volatile) beneath the nostrils.

AMYL NITRITE: Stimulant. For heart attacks with pain. Crush an ampoule beneath the nostrils.

ANAESTHETIC SOLUTION: (Novutox) for local anaesthesia. Used by injecting into tissues where the cut is to be made, and into the gum when extracting teeth.

AROMATIC CHALK WITH OPIUM: For diarrhoea, dysentery, etc. Dose 10 to 60 grains.

ASPIRIN: Relieves mild pain and headache. Used in fevers and rheumatic fever. Dose 5 to 15 grains.

ATEBRIN: For malaria. Preferable to quinine in Blackwater fever. Dose 0·1 gram three times daily for five days, then stop.

ATROPINE: Dilates the pupils. Take ophthalmic tablets strength $\frac{1}{200}$ grain and place one inside the lower lid to dissolve. Used in many eye affections.

BORIC ACID WITH ZINC SULPHATE: Tablets for making up eye lotions.

CALOMEL: Purgative for use at onset of many acute illnesses, and for severe constipation. To be followed by a saline draught next morning. Dose $\frac{1}{2}$ to 2 grains.

CASCARA SAGRADA: Laxative for mild constipation. Dose 20 to 60 grains.

Castor oil: Drastic purgative. Used sometimes in dysentery and poisoning. Dose $\frac{1}{2}$ to 1 fluid ounce.

Caustic stick (silver nitrate): For cauterization of granulating wounds, and callosities. Avoid handling the stick, and moisten before using.

Chloral hydrate: Hypnotic, for restlessness and insomnia. Dose 5 to 20 grains.

Chloroform: General anaesthetic.

Cocaine: Local anaesthetic. Take ophthalmic tablets strength $\frac{1}{20}$ grain and dissolve one inside the lower lid to produce anaesthesia of the eye. Also used for pain of snow-blindness.

Codeine syrup: Relieves cough. For early cough of pneumonia and late cough of bronchitis. Dose 1 drachm.

Collodion (new skin): Painted over gauze to make an air-tight dressing.

Coramine: Heart stimulant. For heart failure. Dose $\frac{1}{2}$ to 1 c.c. hypodermically, repeated as necessary.

Dentalone: For toothache. Apply on wool to cavity in tooth.

Dover's powder: Relieves pain and promotes sleep. Used in many illnesses. Dose 5 to 10 grains.

Dusting powder: For weeping skin surfaces, frost bite, etc. A suitable one is equal parts starch, zinc oxide and boric acid.

Dysentery anti-serum: Only useful when given early in acute bacillary dysentery. (Dose 50 c.c. or more well diluted with normal saline given slowly into a vein.)

Emetine bismuth iodide: For amoebic dysentery. Dose 3 grains, given at night 4 hours after food, in gelatine capsules for a course of 10 doses. Patients to be in bed. Causes nausea, so if vomited give 15 minims of tincture of opium half an hour before the emetine bismuth iodide. Used in chronic cases.

Emetine hydrochloride: For amoebic dysentery during the initial attack and when there are complications, *e.g.* liver abscess. Patients to be in bed. Dose 1 grain dissolved in sterile water and injected into the muscles or under the skin. Course of 10 injections; then a gap of at least three weeks before more is given.

Epsom salts (magnesium sulphate): Saline purgative. For mild constipation, bacillary dysentery, or after calomel. Dose 1 to 3 drachms in half a tumbler of water. Also dissolved in glycerine as a dressing for boils, carbuncles, etc.

Fluorescein: Take ophthalmic tablets strength $\frac{1}{250}$ grains and dissolve one inside lower lid when removing foreign matter from the eyes.

Flavine: Tablets for making up antiseptic lotions.

GLYCERINE: Useful as antiseptic dressing for infected wounds, boils, etc. See Epsom salts.

IODINE TINCTURE (weak strength): Antiseptic, and in Mandl's paint.

LAUDANUM (tincture of opium): For relief of pain, vomiting and diarrhoea in dysentery. Dose 5 to 30 minims.

MANDL'S PAINT: For tonsilitis, Vincent's angina, and sore throats. Paint on back of throat frequently.

MEDINAL: Hypnotic, for insomnia. Dose 5 to 10 grains.

MORPHINE: Relieves pain. Dose $\frac{1}{6}$ to $\frac{1}{4}$ grain hypodermically.

OINTMENT (dilute ammoniated mercury B.P.): For many skin diseases, including prickly heat.

OLIVE OIL: As an enema in chronic constipation when motions are hard. To be followed in half an hour by soap-and-water enema. Quantity 4 drachms.

POTASSIUM BROMIDE: Depressant. For convulsions, fits, etc. Dose 5 to 30 grains. May be combined with chloral hydrate.

POTASSIUM CHLORATE: For sore throats. Dose 5 grains to be sucked slowly.

POTASSIUM CITRATE: For cystitis. Dose 60 grains, combined with 60 grains of sodium bicarbonate taken in water every 4 hours.

POTASSIUM PERMANGANATE: Antiseptic. For gargle, snake bite, etc.

QUININE BIHYDROCHLORIDE: For malaria. Dose 10 grains thrice daily for first week, then 5 grains twice daily for several months. In blackwater fever give alkalies (see potassium citrate). Better to use Atebrin.

SODA MINT TABLETS: For indigestion. Suck one tablet slowly.

SODIUM BICARBONATE: For indigestion, primary dressing for burns, and combined with potassium citrate for cystitis.

SODIUM CHLORIDE: For making up normal saline solution for gargling, infusions by the bowel, intravenous treatment. Dissolve 80 grains in 1 pint of sterile water.

STRYCHNINE: Stimulant. For stimulating the respirations and heart in many conditions, including drowning. Dose $\frac{1}{32}$ to $\frac{1}{8}$ grain.

TANNAFAX: For burns.

VASELINE: For cracked lips, and lubricating enema nozzles, etc.

The main stores are conveniently packed in Venesta light-weight boxes fitted with hinged lids and locks. If more than one case is taken divide the stores into duplicated sets when packing; thus should one case get lost there is still a complete set in reserve.

Whenever possible take drugs in tablet form. Pack bandages, dressings, and plasters in tins.

Weights and Measures

Solids

60 grains	= 1 drachm—or about 1 teaspoonful.
8 drachms	1 ounce—or about 2 tablespoonfuls.

Note that this is not the avoirdupois ounce of 437½ grains.

Fluids

1 minim	=about 1 drop.
60 minims	1 fluid drachm, or about 1 teaspoonful.
8 fluid drachms	1 fluid ounce, or about 2 tablespoonfuls.
20 fluid ounces	1 pint, or about 2 tumblersful.

Metric equivalents

1 cubic centimetre	= 17 minims approx.
1 litre	35 fluid ounces approx.
1 gram	15½ grains approx.
1 kilogram	35 ounces, or 2·2 pounds.

ANTISEPTIC LOTIONS

ACRIFLAVINE (British Drug Houses): Dissolve 1 tablet in ½ pint of boiled water to make 1 in 1000 solution for cleansing and packing wounds.

DETTOL (brown fluid): Use 1 teaspoonful in every ½ pint of spirit for sterilizing instruments. For wounds and dressings 1 teaspoonful in 1 pint of boiled water; but stronger solutions are harmless. Also for gargling in same strength.

GLYCERINE: can be used on boils, carbuncles, or infected wounds, but causes pain. Better is magnesium sulphate crystals in glycerine to make a paste which is used for same purpose; if it dries up add a little water. Warm glycerine, or glycerine with carbolic is useful for ear drops.

PICRIC ACID (crystals): dissolved in water to make saturated solution for burns.

POTASSIUM PERMANGANATE: Take as tablets 1 grain in each. Dissolve 1 tablet in ½ pint of boiled water to give lotion for poisoned wounds, or injection into tissues round a snake bite, or 1 in a pint of water for gargling.

SALINE: Take 40-grain tablets of sodium chloride (Burroughs Wellcome). To make normal saline for bathing wounds, eyes, etc.,

dissolve 2 tablets in a pint of clean boiled water. Use hot for gargling. For hypertonic saline use more tablets than this.

TANNIC ACID: Take Tannafax (Burroughs Wellcome); or tannic acid spray outfit (Crookes' Laboratories Ltd.). For burns.

Compressed bandages, boric lint, sterile gauze, clinical thermometers, hypodermic syringes, splints, etc. and special materials for local diseases.

SPECIAL INDEX FOR HEALTH, DISEASE, AND INJURY

EMERGENCY DENTISTRY. *By Alexander MacGregor*

These notes are brief, and emergency treatment often falls far short of the ideal.

EQUIPMENT

A pair of heavy lower root forceps, and one of upper; mouth mirror; pair dental tweezers; dental probe; cartridge type local anaesthesia syringe, such as Waite's; tube of long ($1\frac{5}{8}$ inch) and another of short (1 inch) double-ended needles for above; box cartridges anaesthesia solution, novocain 2 per cent. with adrenalin (Novol brand in sealed vacuum tins of 25 are suitable for transport). A small quantity, say 1 oz., of oil of cloves; powdered zinc oxide; *Liquor arsenicalis*; silver nitrate, 25 per cent. solution; and tincture of iodine and aconite. Small quantity of compressed antiseptic mouth wash tablets.

DIAGNOSIS AND TREATMENT

Tooth ache is seldom, if ever, referred from one side of the jaw to the other, but frequently from the lower jaw to the upper, or upper to lower of the same side. Thus pain in the upper jaw may be due to a tooth on the same side in the lower jaw and vice versa.

Examine the teeth with the mirror and probe to see if there are any carious holes, loose teeth, discoloured or inflamed gums, and diagnose from the following points:

Pain, transient, not severe, worse on eating sweet food, very cold or hot food (sweet especially), no pain on pressing tooth, hole in tooth seen: probably exposed dentine or exposed pulp.

Clean debris from hole in tooth and plug hole with paste made of zinc oxide and oil of cloves in which a few fibres of cotton wool are mixed to give strength. This sets hard in about one hour and may be left in as long as it will stay.

Pain prolonged, severe, may be aggravated by heat, may throb, no pain on pressing tooth, hole in tooth or large filling in tooth visible: probably acute inflammation of the pulp.

Treat as above. If pain persists, extract tooth.

Pain prolonged, severe, may throb, often pain on tapping tooth, hole or large filling in tooth visible, tooth may look discoloured or

be known to be dead, bone of jaw and neighbouring soft tissues may appear swollen round tooth: apical abscess.

Extract tooth. If abscess has spread to neighbouring bone and adjacent soft tissue, incise abscess as well, from inside the mouth whenever possible, but if pointing through cheek it must be incised externally.

Tooth may appear extruded slightly from socket, painful on pressure, no pain with sweet food, heat may relieve pain, not necessarily any hole seen in tooth, surrounding gum may appear inflamed and pus may be expressed from the socket of the tooth: acute inflammation of the membrane surrounding tooth.

Paint gums round teeth with tincture of iodine and aconite and apply heat locally. Avoid biting on tooth. If this fails, extract tooth.

Gums sloughing and ragged round tooth, foul smell: Diagnosis not certain without bacteriological tests, but treat as Vincent's angina. (See p. 437.)

Mouth wash frequently; twice a day apply *liquor arsenicalis* sparingly on wool to the gums. Every other day apply silver nitrate 25 per cent. solution sparingly on wool. (Caution: Strong caustic.)

Gums swollen, sore, bleeding, teeth becoming loose, haemorrhage elsewhere, *e.g.* under the skin of shin: early scurvy.

Administer Vitamin C. (See Scurvy, p. 425.)

Gums sore round particular tooth or group of teeth associated with tartar on teeth: localised inflammation of gums.

Chip off tartar with suitable instrument and apply silver nitrate sparingly.

For small painful ulcers in mouth apply silver nitrate, 25 per cent. solution, to the ulcer sparingly, and use mouth washes.

EXTRACTION OF TEETH

Local Anaesthesia

For the upper teeth use a short needle. Read the instructions with the cartridge syringe carefully before assembling. Boil the syringe and needle and then fit cartridge into the syringe. Apply iodine to the points of injection, and inject three-quarters of a syringeful under the gum on the outer side of tooth, opposite the point where

the apices of the roots of the tooth are thought to lie. Push the syringe in where the mucous membrane inside the lip joins the mucous membrane of the gum, until the point is felt to touch the bone. Inject slowly. The remaining quarter of the syringeful is injected into the palate, the needle pushed in until it reaches the bone opposite the tooth and about $\frac{1}{2}$ inch away from it towards the mid-line. Wait 10 minutes before starting to extract the tooth.

For lower teeth use a long needle and give a nerve block anaesthesia on the side of the affected tooth thus: After boiling the syringe and fitting in cartridge, apply iodine to point of injection. For a tooth on the patient's right side, lay the forefinger of the operator's left hand along the tops of the lower teeth of that side, and slide the finger back until the bone of the angle of the jaw is felt through the mucous membrane inside the mouth. (For a tooth on the left side, use the forefinger of the right hand and hold the syringe in the left hand.) Continuing as for the right side, with the syringe held in the right hand, insert the needle $\frac{1}{2}$ inch farther back than the tip of the finger opposite the centre of the finger nail; the barrel of the syringe being over the pre-molar region of the opposite side. Insert the needle in the line of the syringe until the bone is felt and inject three-quarters of the syringeful slowly. If the needle has been inserted in the correct position, with the point touching the bone, about two-fifths of an inch of needle should be still visible. Withdraw the needle and inject the remaining quarter of the syringeful into the gum opposite the roots of the tooth on the outer side where the lip folds meet the gum. Wait 20 minutes before extraction.

The first signs of successful anaesthesia are a tingling sensation in the lower lip of the injected side. If it fails due to faulty technique, use another cartridge in the syringe and make a further injection into the gum of the inner (tongue) side of the gum, opposite the apex of the root of the tooth. If the block anaesthesia has failed, this will give partial, but not complete anaesthesia.

Extraction

For the right lower teeth stand behind the patient on his right side, so that the handles of the forceps emerge from the right corner of the patient's mouth. For all other teeth stand facing the patient.

Place the blades of the forceps in position on tooth, and push them

towards the apex of the root of the tooth, using a fair degree of force, so that the blades are pushed well through the junction of the gum with the tooth. Keep the forceps applied to the tooth, and in this position slowly and gently try to move the tooth, partly rotating it (especially in the front teeth) and partly rocking it inwards and outwards (especially in the back teeth), until the tooth is delivered. At no time attempt to wrench violently at the tooth or to pull it straight out from the socket.

If a root is fractured and cannot be extracted, wash well out with antiseptic solution as hot as can be borne and place a pledget of wool soaked in oil of cloves in the socket, removing pledget after eight hours. Wash out, and, if necessary, replace. Do not leave the same pledget more than twenty-four hours without removing it.

Septic sockets and pain following extraction should be treated as for fractured roots above.

If persistent haemorrhage follows extraction loose clots should be gently removed, the mouth washed out, and pressure applied to the area by inserting a clean pad over the affected area and instructing patient to keep the jaws firmly closed upon it for at least half an hour. If this fails, soak a small pledget of wool in adrenalin or turpentine, and press as above. If this fails and free bleeding persists after some hours, stitch the socket from one side of the gum to the other to occlude the bleeding area.

CARE OF TEETH

Visit the dental surgeon and get a thorough overhaul with X-rays of all teeth, before starting on any prolonged journey.

Take out dentures and clean at night.

Try to avoid finishing a meal with sticky sweet or floury foods. Fruit is better.

Picking the teeth is better than brushing, and when far from civilization can be done without offending susceptibilities.

NOTE BY THE EDITOR

In arranging medical stores remember that a traveller is often asked to doctor the local sick and injured, and may do well to carry large stocks of the simpler remedies to deal with rheumatism, sores, abscesses, toothache, dysentery, inflammation of the eyes, etc., as well as more serious conditions. A very little doctoring will gain much confidence and friendliness, especially if a few cures are made.

"Afa was . . . suffering from Filaria. One day he arrived complaining of 'breeze for side of eye,' which upon examination proved to be a blister-like swelling on the cornea of his left eye. He waited at the camp until the little thread-like worm began to appear, and then submitted to the operation unflinchingly, despite the crude implements that were used. The eye had to be slit with a specially sharpened and sterilized skinning-scalpel, the worm seized with the finest pair of entomological forceps in our possession, and coaxed out with match sticks dipped in melted rubber. I may add that the usual weak permanganate solution was applied and an eye-shade constructed of gauze and sticking plaster. All our fears as to the success of the operation were subsequently allayed by a decided improvement in Afa's marksmanship."
Sanderson. Cameroons. 85.122.

The account of an expedition should always include a note on the health of the party, and on any unusual or unexplained sickness, with comments by authorities on the return. Notes on acclimatization and deterioration at very high altitudes are important, especially in regions other than the Himalaya, from which most of our present knowledge is derived.

"Malaria developed only after the return, and might have been avoided by not sleeping without nets on the river-boat before returning from Bartica. There were no serious accidents. Bush-sores, and septic bites produced widespread effects. The Expedition proved that it is definitely possible for unacclimatized undergraduates to work in the rain-forest effectively and without calamitous results. It was in fact the members over twenty-three who provided five out of the six malarial cases; the youngest came off best."
O.U.E.C.2. British Güiana.

"We got something of a fright at Dochen, where our postal agent, Lobsang Tsering, had a fall from his horse and broke his collar-bone. The administration of anaesthetics at an altitude of over 14,000 feet is evidently a risky business. Lobsang Tsering did not come round for some time, and Greene and McLean had to work very hard on him before he came to life again."
Ruttledge. M.E.E. 1933. 83.4.

"Within half an hour of returning to our high camp after climbing the peak I was stricken by a fever. It started by a violent attack of shivering and an acute pain in the top of the right leg. It lasted for about thirty-six hours, was accompanied by some mild delirium, and left me suddenly as it had come. Nearly a week later Tilman was confined to his bed by a complaint exhibiting almost exactly similar symptoms." *Shipton. Nanda Devi.* 85.311.

"The objection to climbing earlier in the year is the powerful and cold wind. It is rather strange that high up on the mountain the more exercise the climber takes the colder he becomes. That is because the least little bit of exercise causes violent panting, and since the air that the climber is breathing is at a fairly low temperature, there is a general cooling down from somewhere in the lung regions. This is rather a strange feeling which I remember Wyn Harris and I got, to some extent, when we left Camp VI early in the morning when the north side of the mountain was still in shadow. We had to stop occasionally in order to reduce the speed of our panting and warm ourselves up." *Wager. M.E.E.* 1933. 83.11.

"The policy of slow acclimatization appears on the whole to have worked well. But the need for striking the balance between it and the parallel process of deterioration should never be lost sight of. Our plan was to establish the higher camps and go for the summit after not more than five days at Camp IV. In the event, bad weather interfered with every plan and upset every calculation." *Ruttledge. M.E.E.* 1933. 83.9.

"With too prolonged acclimatization, deterioration sets in, and when planning an attack this has to be considered. When Shipton and I first went up from the North Col to make a reconnaissance towards Camp V we climbed 1500 feet in about one and a half hours. At the same time, I very much doubt whether we should have been able to have climbed to 28,000 feet. When we went up later we found we could only manage about 600 feet an hour from the North Col to Camp V. But given the same easy ground above Camp VI, I think we could have climbed at 400 to 500 feet an hour; and so what you lose on the roundabouts of deterioration you gain in the swings of acclimatization." *Smythe. M.E.E.* 1933. 83.14.

"A more comprehensive dental equipment was badly required. Teeth gave most trouble, due possibly to the sudden changes of temperature from the interior of a hut or station, to the outside. Extraction is a drastic remedy and provision ought to be made for an automatic drill to enable satisfactory stoppings to be inserted. Anaesthetics, both local and otherwise, ought also to be provided." *Glen. North-East Land.* 90.195.

CHAPTER XXI. INJURIES

By Dr. J. W. Cope

FRACTURES OF BONES

Fractures may be produced by direct violence, in which the break is usually transverse and the bone is broken at the site of injury; by indirect violence where the injury is received at a distant point and the bone breaks at its weakest part; or by muscular violence.

Signs of fracture are pain, swelling, bruising, grating on movement, abnormal mobility, and deformity. Deformity may be angular, producing a bend in the limb; overlap, producing shortening as compared with the opposite side; or rotatory, one fragment twisting round in relation to the other.

The deformity must be reduced as soon as possible and the fragments brought end to end. This may be possible by ordinary manipulation, which is usually firm traction (pull) on ends of limb. If the muscles will not give way, making it impossible to reduce the fracture, manipulate under an anaesthetic. If this is not available, attempt to reduce as soon as possible after injury, assisted by an injection of ¼ grain morphia.

If there is considerable shortening, and powerful muscles (*e.g.* thigh) involved, it is unlikely that manipulation, even under an anaesthetic, will succeed, and reduction by gradual traction will be necessary, using a special splint which will be described under "Fracture of the Thigh Bone."

Having reduced deformity, fix the fragments by splints or plaster.

Splints

Plain wooden splints, easily made in an emergency, should be well padded with wool or other soft material. In bandaging the limb to the splint, see that the bandage is not too tight or it will interfere with the circulation.

The guttered splint is made of malleable aluminium well padded, or of Gooch splinting if available.

Special splints (Thomas' Telescopic) should be carried. They are especially useful in fractures of the lower limb, where it is necessary to use gradual traction to reduce the deformity. Apply adhesive strapping down both sides of the limb; beyond the ankle, fold the

free end of the strapping on each side back on itself to cover the sticky part; the two free ends thus left, each about 8 inches long, may then be attached to the spreader: a flat square of wood about 3×3 inches, which will lie easily between the bars of the splint. Fix the two ends of the strapping to this by tacks or screws. Through the centre of the spreader, bore a hole through which a stout cord with knotted end is passed. The function of the spreader is to keep the severe pressure of the strapping off the sides of the ankles. The ring of the splint is passed over the limb and fitted well home against the buttock. The cord from the spreader is pulled taut round the lower end of the splint and tied there. Thus extension is obtained by counter-traction from the buttock.

The limb is supported in the splint by flannel loops or bandages passed from side to side beneath it. Keep the foot at right angles and prevent it from dropping by suitably arranged straps. The whole splint is then suspended for the comfort of the patient and convenience of nursing.

Plaster

Plaster is easily portable. Plaster bandages ready prepared are supplied in tins; made of muslin well impregnated with plaster powder. Immerse in slightly warm water for two or three minutes, remove, and gently squeeze to get rid of excess water; then apply in puttee fashion to the limb.

First cover the limb with a layer of stockinette or wool, and apply the first layers of the plaster evenly. The bandages are then smoothly wound on, up and down the limb, not too tightly nor too loosely. In all about six thicknesses. Generally include in the plaster the joints above and below the fracture.

After applying a plaster to a limb, carefully observe the circulation, as judged by colour and warmth of the toes or fingers. If suspicions are aroused, the limb should be well elevated and warmth applied. If colour does not return in a short time, cut up the plaster and ly prise it open to give more room for swelling.

Alternatively, a plaster bandage may be made into a gutter splint. The necessary length is marked out on a flat surface and the wet bandage is laid out layer after layer, backwards and forwards, until a slab is obtained. This is then applied to the limb and moulded to it, before it sets.

OPEN FRACTURE. (See also Contaminated Wound, p. 438.)

Treat an open fracture by free excision of the wound to prevent a contaminated one becoming an infected one; stitching the wound to close the fracture; very careful immobilization, most important; administration under the skin of anti-tetanus and anti-gas-gangrene serum, which should always be carried in ampoules.

FRACTURE OF FINGER

Reduce the fragments by pulling them apart. Fix on a straight wooden splint to which the finger is bound by strapping; or bend the finger well into the palm of the hand and hold it thus by strapping, which runs over the back of the hand, over the back of the finger, and on to the front wrist.

FRACTURE OF THE WRIST

Produced usually by falling heavily on the outstretched hand or by back-fires from a starting handle, etc. The lower end of the outer forearm bone (*i.e.* thumb side) is displaced backwards, and tilted backwards, and displaced laterally, giving a dinner-fork deformity of the wrist. If available, an anaesthetic should be used for reduction.

To reduce the fracture, pull the hand firmly to disempact the fragments, and bend the wrist downwards to correct the backward displacement and tilt, at the same time deviating the hand to the little finger side. If properly reduced, there is little tendency for the displacement to recur.

Fix by using a Carr's splint, or moulding a plaster slab on the back of the hand, wrist, and forearm, held in place by adhesive strapping.

FRACTURE OF THE FOREARM BONES

Angular deformity easily reduced by simple manipulation, but any shortening must be overcome by a powerful pull on the hand and a counter-pull from the elbow. Fix by plaster bandages from above the elbow to just below the wrist, with the hand and forearm in the position of holding a glass.

If not shortened may be fixed by a gutter splint.

FRACTURE OF THE ARM BONE

If the Humerus or arm bone is fractured at its lower end near the elbow, it is necessary to distinguish a fracture from dislocation of

the elbow. Study the bony points of the elbow. In a dislocation, the point of the elbow is carried backwards in relation to the other two bony points, whereas in a fracture through the lower end of the bone, all three retain their relative positions.

Reduce the fracture by pulling the forearm, and bending of elbow. To fix suspend the wrist from the neck by a clove-hitch round the wrist of such length that the elbow joint is bent about 45°. Carefully watch the circulation. Any congestion of the fingers is warning to lower the wrist and decrease bend of the elbow.

In fractures of the shaft of the bone reduce deformity by traction in the long axis of the limb and fix by a short wooden splint on the inner and outer sides of the arm; alternatively, a gutter splint of Gooch splinting. If the deformity cannot be reduced, gradual traction will be required. Use a Thomas' splint, the ring fitting round the shoulder and against the chest wall, standing out at right angles to the padding. Counter traction is obtained by tying the ends of the strapping extension previously applied to the skin, tightly over the end of the splint. Sagging of the arm at the side of the fracture is prevented by loops of the bandage passed beneath the arm from side to side of the splint.

Fracture of the upper end of the bone near the shoulder has to be distinguished from dislocation of the shoulder-joint. In a dislocation, the rounded contour of the shoulder is lost and the upper end of the bone may be felt out of its socket in an abnormal position. In a fracture of the upper end of the bone, flattening is not so marked, and on gentle movements of the arm, grating will be felt.

Treat by carrying the arm in a sling for at least a month. Apply massage early to keep the shoulder muscles in good condition. After about ten days in the sling, the arm may be gently moved with assistance. If the deformity is marked, try to reduce it by long axis traction at right angles to the body, after which it is carried in a sling as before. Anaesthetic advisable for this manipulation.

FRACTURE OF COLLAR BONE

Usually broken in the middle of the bone by falling on the arm or on the point of the shoulder. The broken ends can usually be felt beneath the skin.

Reduce the fracture by bracing back the shoulders and supporting the weight of the arm. Fix by the three handkerchief method. Roll

two handkerchiefs and tie with loops over the shoulder and under the armpit on each side. The third is used to draw the two loops tightly together across the back. The arm is carried in a sling for three weeks, when gentle movement of the shoulder may be started. If this produces pain, retain the sling.

FRACTURE OF THE RIBS

May be caused by direct blow or as a result of crushing. There is severe pain localized over the fractured bone, which is aggravated by deep breathing, coughing, sneezing, etc. Grating may be felt during a deep breath.

Treat by broad adhesive strapping from below upwards on the affected side of the chest reaching from the mid-line of the chest in front as far round as the spine behind: four or five strips each overlapping the one below: each applied with the chest in expiration.

FRACTURE OF THE ANKLE

Usually from a slip or fall when the ankle is forcibly twisted outwards. The deformity may be obvious and grating felt on examining the ankle. In less severe fracture, it is difficult to distinguish from a sprain. If maximum tenderness over bone, it is probably a fracture; in a sprain the tenderness is confined to the ligaments and the soft tissues round the ankle.

In a fracture, it is important to reduce the deformity, otherwise a very painful foot will result. Study the displacement carefully, and work out manoeuvres of reduction. Always attempt reduction; anaesthetic if available.

The displacement is of the whole foot backwards on the leg; or of the whole foot outwards on the leg; and the foot is twisted outwards. Therefore, in reduction, the foot is pulled forward with the heel resting in the palm of the hand. This is easier if the knee is bent at the same time. At the same time, the foot is pushed inwards whilst counter pressure is made against the inner side of the shin, with the other hand just above the ankle.

Fix by a series of plaster bandages applied from the toes to the level of the knee, of adequate thickness. Best applied over wool or stockinette to allow for swelling. Afterwards carefully watch the condition of the toes. Keep the plaster on for six to seven weeks,

or longer for a heavy person. It is always advisable, if reduction is good and a satisfactory plaster applied, to commence walking early. At first, a crutch will be necessary, but later a stick will suffice. Walking is made easier if a heel of wood or rubber can be attached to the bottom of the plaster.

If plaster not available, splint the leg on a well-padded back splint with a foot piece at right angles, and the leg and foot secured by bandages.

FRACTURES OF BOTH THE LEG BONES

Owing to the superficial position of the Tibia, these fractures through both bones of the leg are fairly easily recognized, the deformity being evident. For the same reason, the fragments are liable to come through the skin, producing a compound fracture. (See treatment of wounds and open or compound fractures.)

Reduce the deformity by traction in the line of the limb. If much swollen, a full anaesthetic necessary. Set in plaster from the toes to half-way up the thigh. Before putting on the plaster bandages, see that the lower part has not rotated owing to the weight of the foot; and that backward bending at the site of the fracture is corrected. If this is difficult, slightly bending the knee will help. To correct rotation, the kneecap and the foot should look forward in the same straight line.

If it is impossible to reduce the fragments, immobilize the leg on a well-padded back splint with foot piece, until an apparatus for gradual traction can be applied.

FRACTURE OF THE TIBIA ALONE

Owing to the splinting effect by the other bone, there is very little displacement in this fracture.

Before fixing by plaster or on a back splint, the only point for special care is to correct twisting.

FRACTURE OF THE KNEECAP

There is a great tendency in clean transverse fractures for the powerful thigh muscles to pull the upper fragment up the thigh.

Fix the knee joint on a short back splint completely straight. At the same time a rolled bandage, placed above the upper fragment and firmly bound in position, will tend to prevent excessive separation.

FRACTURE THROUGH THE THIGH BONE

To steady the limb during transport lash a long wooden splint firmly down the side of the body from the arm pit to the toes: towel wrapped round the chest fixes the upper part of the splint.

Owing to the powerful thigh muscle, there will be considerable shortening, which will require gradual traction to overcome it. Use the easily portable Thomas' Splint. Apply adhesive strapping to the leg (see Introduction) for extension. Fit the splint over the limb with the leather ring well home against the buttock. The cords from the spreader are then pulled taut and tightly tied over the end of the splint, thus getting a strong counter pull from the buttocks. The slings that support the weight of the leg are then so arranged that the limb is well supported at the site of the fracture, so as to check backward sag.

For the comfort of the patient, suspend the whole splint and limb, thus giving greater freedom of movement for the body. Watch the position of the foot. It must not drop, but must be kept at right angles, and it must be prevented from falling to one side.

FRACTURE OF THE PELVIS

Usually produced by severe crushing. More important than the fracture itself are injuries to the internal organs, particularly the bladder. For these, skilled surgical assistance is essential.

Move a fractured pelvis with great care. As soon as possible, lay the patient on a rigid surface. Bind the pelvis with strapping, or bandages, or a towel. Prevent excessive movement of the legs by tying them together. Nurse on a mattress with boards beneath to give rigidity. Special care to prevent sores.

FRACTURE OF THE SPINE

Usually produced by a fall from a height, landing on the feet or buttock; or by weights falling on the bent back.

Injury associated with a severe degree of shock, and the spinal cord frequently involved, indicated by paralysis of the legs. Handle the patient with extreme care, and before he is moved roll gently on to his face. To lift raise from the shoulder and thighs, and never allow the spine to bend forward. Nurse face downwards with one or two pillows under the chest to maintain the extension of the spine.

After the accident, retention of urine may develop (see p. 436). Similarly, the bowel is affected, should be evacuated by enema (see p. 385). In nursing spinal injury with a degree of paralysis, it is very important to prevent pressure sores develop over bony points. Should paralysis be followed after fourteen days or so by spasms of the limbs, bandage them to a well-padded splint.

FRACTURE OF THE SKULL

In a fracture of the vault of the skull a depression may be seen or felt, or a fissured fracture may be seen in the depths of the scalp wound. A fracture of the base is usually associated with some degree of concussion. It is suggested by escape of the cranial contents, or injury to the nerves. The latter is usually seen as a paralysis of the face muscles. The former may consist of the clear watery fluid that surrounds the brain, or even brain substance itself escaping down the nose or through the wound. Bleeding usually occurs, around the eye-ball, down the nose, into the back of the throat, or from the ear. For treatment of Concussion, see p. 394.

Sepsis in a scalp wound may be serious. It is very important here to cleanse the wound thoroughly: see Wounds, p. 438. Shave away the hair, remove dirt or loose spicules of bone, and excise the edges of the wound freely. Scalp wounds bleed freely; control temporarily by pressure of the fingers round the wound. Control vigorous bleeding by deep stitches. The wound edges should be carefully sutured; a firm bandage over a thick pad will prevent oozing. If there is bleeding from the ear, avoid interference with the ear, and cover with a sterile pad of wool only.

DISLOCATIONS

The finger is frequently dislocated and may prove difficult to reduce. First increase the deformity before pulling out. This will enable the dislocated bone to be levered back. Afterwards support the joint by strapping.

A dislocated elbow must be distinguished from a fracture through the lower end of the arm bone. (See Fracture of the arm bone, p. 458.) Usually easily reduced by placing the knee in the hollow of the elbow. With a firm grip on the forearm, it is pulled forward and bent round the knee. The elbow usually goes back with a click. Support the arm in a sling for at least a fortnight, when gentle movement may be started.

A dislocated shoulder is usually produced by a fall on the outstretched hand. There is great pain over the shoulder and inability to move the arm. The contour of the shoulder is flattened owing to the bone being out of its socket, and the bone may be felt protruding in an abnormal position.

Early reduction will be possible without an anaesthetic, but later, when the muscles stiffen and bruising develops, it will be more difficult. Pull the arm gradually out at right angles to the body, with the palm facing upwards. With a grip round the forearm, make firm traction outwards. At the same time, an assistant pulls in the opposite direction on a roller towel round the chest. As the pull of the muscles is gradually overcome, the head of the bone slips back into place.

After reduction, carry the arm in a sling, and massage the shoulder muscles from the start. Gentle assisted movements may be carried out early, but avoid raising the arm sideways from the body, since this may produce recurrence of the dislocation.

SPRAINS

A badly sprained wrist may be difficult to distinguish from a fracture of the lower end of the forearm bone. In sprain, the bony points on either side of the wrist retain their relative positions; in a fracture the thumb side will be displayed upwards. Bind a sprained wrist firmly over wool and carry the arm in a sling. Keep the fingers moving from the start, and massage the wrist daily. When the bandage is discarded, bind the wrist with adhesive strapping to prevent excessive movement and pain.

A sprained knee usually results from a twist which tears one of the ligaments: commonly that on the inner side. There is usually sickening pain, and it may be found impossible to put weight on the leg. The joint soon swells, and bruising may develop over the inner side of the knee. Maximum tenderness is on the inner side just behind the knee-cap, and pain on attempting to bend the leg outwards.

Bind the knee as soon as possible with a firm compression bandage, thus: put wool evenly round the knee and firmly bandage; then more wool, again bandage. Thus an even, firm pressure is obtained and swelling of the joint is prevented. Rest for a day or two in bed; make a cage to keep the weight of bedclothes off the foot, since turning the foot will strain the ligament and cause pain. During

this time exercise the thigh muscles regularly by alternately bracing and relaxing them, and massage the thigh. It is most important to keep the muscles in good condition, as they waste very rapidly. After a few days, walk with the knee still firmly bandaged, or supported by a short back splint. A wedge ¼ inch thick nailed to inner side of the sole and heel of the boot will throw some weight off the sprained ligament and is a great help.

A sprained ankle from twist of the foot is very common and most disabling. An inward twist injuring the ligaments on the outer side of the ankle is the most common. It is important to verify which way the foot was twisted, and to confirm which side of the ligaments is involved by noting the point of maximum tenderness round the ankle, and which movements cause pain.

For two days the ankle must be firmly bound with a compression bandage. (See knee.) This usually means bed, with the foot raised. After two days strap the ankle with adhesive plaster. The outer ligament sprain (*i.e.* inward twisting injury) must be strapped up with the foot firmly twisted outwards, to take the weight off the sprained ligament, and vice versa for inner ligament sprains.

Use 1-inch strapping. Start on the inner side of the leg half-way down the shin. Pass slightly over the back of the inner prominence of the ankle. Draw very firmly across the sole of the foot, and then keeping the foot twisted outwards, run the strapping up the outer side of the leg about half-way up, keeping up a good tension all the time. In front of, and slightly overlapping this, apply another strip of strapping in the same way.

A third strip, again in front of the other two, should start on the outer side of the leg at the same level as before, and pass obliquely across the front of the leg, round the inner side of the foot, across the sole, round the outer side of the foot, and back obliquely across the front of the leg to finish on the inner side. Round the outer side of the foot, maintain strong tension all the way. Strapping thus applied will keep all the strain off the injured ligament. Reverse the directions for a sprain of the inner ligament, *i.e.* outward twist injury.

For additional support nail a ¼-inch wedge to outer side of the sole and heel of the boot. Normal walking without the aid of a stick should be possible and be encouraged.

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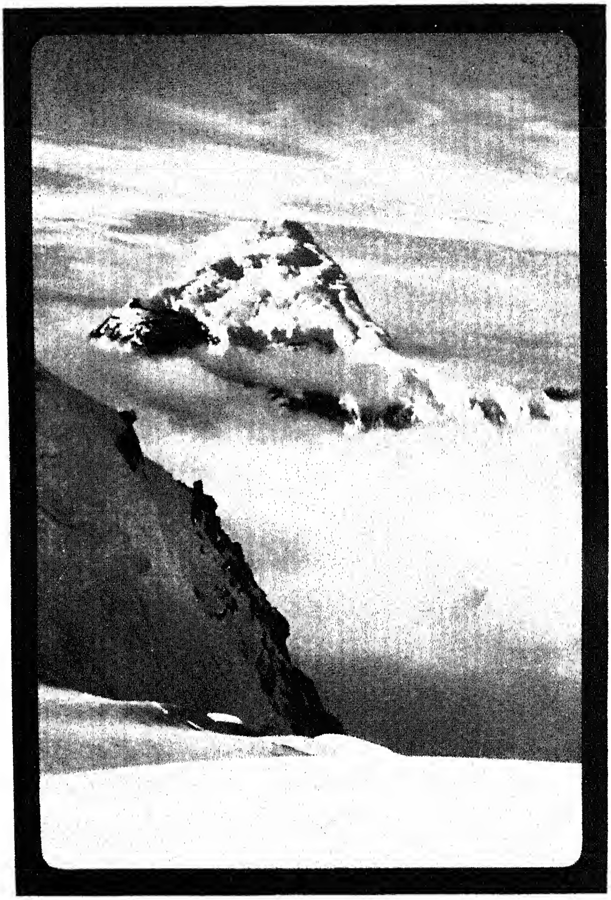

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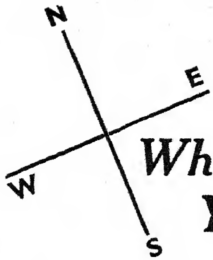

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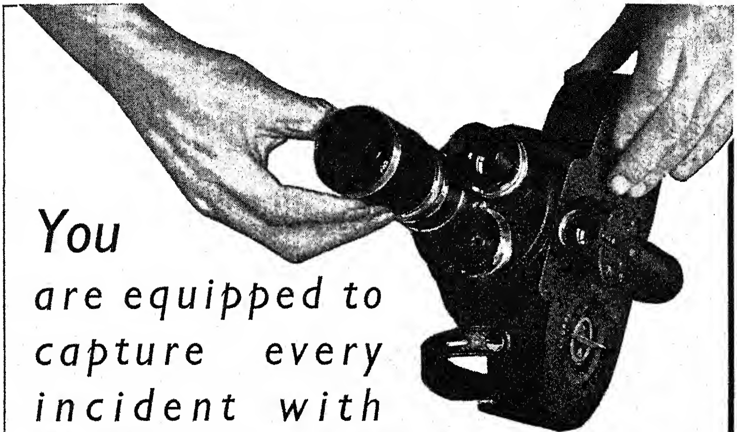

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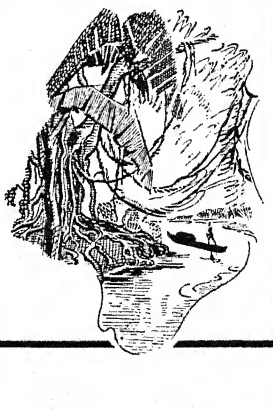

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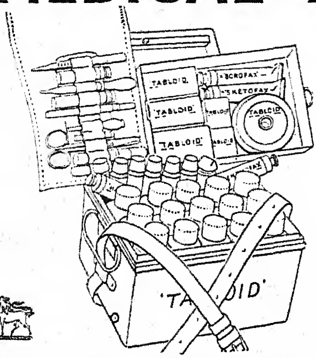

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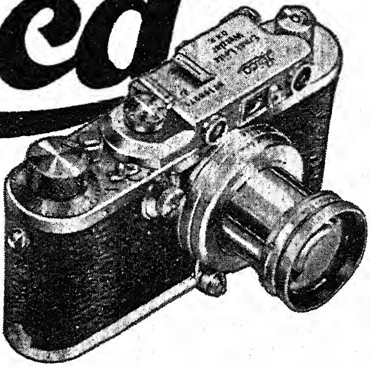

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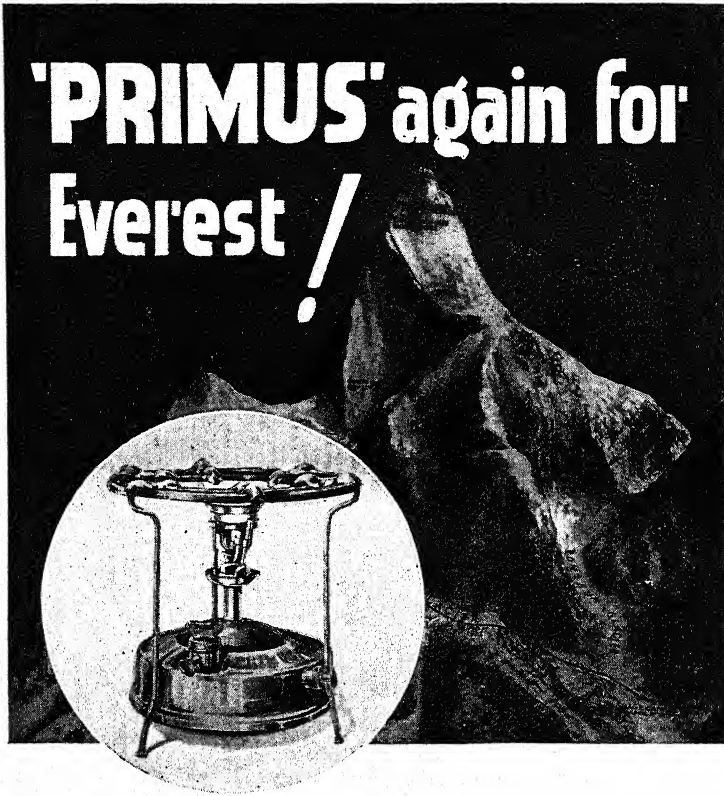

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